CITY OF COLUMBIA

CLIMATE ACTION & ADAPTATION PLAN

May 23, 2019 – Formatted draft to be on June 17 City Council agenda.

INTRODUCTION

Columbia's Climate Action & Adaptation Plan (CAAP) lays out a vision and strategy to address risks posed by climate change and to contribute to international efforts to reduce greenhouse gas (GHG) emissions. Cities are poised to lead climate change efforts. Collectively, the world's cities are responsible for 70% of GHG emissions.[1] Cities are also at the frontlines of bearing climate change impacts, such as urban heat islands, flooding, drought and risks to optimal public health. With this Plan, Columbia is joining a global coalition of cities committed to reducing climate change impacts.

The effects of increased global GHG emissions threaten Columbia's resources and quality of life. Extreme heat, drought, higher incidence of severe storms and reduced air quality are growing threats in Columbia due to climate change. By taking action to reduce our community's contribution to worldwide emissions and prepare for climate risks, the City of Columbia can better protect the wellbeing of its residents for decades to come. The purpose of this plan is twofold:

1. To prepare Columbia's natural and built environments (neighborhoods, resources and systems) and people to be more resilient to the impacts of climate change.
2. To reduce GHG emissions communitywide through targeted municipal, residential, industrial and commercial activities.

The plan was written for the community and by the community. Significant contributors included the public, the Mayor's Task Force on Climate Action & Adaptation Planning (Task Force) and City staff. In development since 2017, through a process that included multiple community and City of Columbia staff workshops, Task Force meetings and two public surveys, this plan focuses on *effective* actions. These actions achieve the greatest emission reductions and increase our community preparedness in the most cost-effective and equitable manner. The entire community—businesses, residents and municipal government—all have a role in both implementing the plan and enjoying its benefits.

[1] "Hot Cities: Battle-Ground For Climate Change." UN Habitat. 2011. http://mirror.unhabitat.org/downloads/docs/E_Hot_Cities.pdf

Mayor's Statement

People have lived in the varied landscapes of the place we call Columbia for thousands of years.* In 1818, European settlement of this area started with a town called Smithton, on the hills just to the west of the intersection of Providence and Broadway. Settlers decided to stay and work to build a life because of the opportunities this place offered them: a reliable water source and productive land to sustain them and help to build the community we call ours today. The journey from Smithton to Columbia has been one of enormous changes. Footpaths became highways and a village grew to Missouri's fourth largest city. The changes that made Columbia came along with community vision, effort and a belief in the potential and value of Columbia as a community. This Plan is an important moment of growth in the story of our community. It is a decision to put forth the effort, change and perseverance required to keep Columbia resilient and thriving.

Just as the founders of Smithton had to reimagine the land before them and believe in their ability to meet the challenges of building a new community, this Plan requires an openness to change and new ideas to ensure that Columbia continues to be the best place to live, work, learn and play.

Sincerely,

Brian Treece, Mayor

*The City of Columbia, Missouri, respectfully acknowledges the indigenous occupants of the land. *We welcome information and stories with which we can* pay respect to their ancestors and descendants.

Letter from the Mayor's Task Force on Climate Action & Adaptation Planning

The debate on man-made climate change has been closed for some time, leaving us with only two important questions: What are we going to do to reverse our direction and start an improvement process? And simultaneously, what are we going to do to better prepare ourselves to withstand the effects of a changing climate? Change can be uncomfortable, and many members of the community will question the need to move rapidly to implement this Plan. Achieving the implementation of this Plan will offer many benefits to our community, including cleaner air, better resilience to severe weather and improved health.

Columbia began answering these questions in 2017 when, with Council approval, Mayor Treece signed on to the Global Covenant of Mayors for Climate and Energy. The enclosed document, Columbia's Climate Action & Adaptation Plan, is another step in our participation in that Covenant.

This Plan is the result of Columbia City staff, Cascadia Consulting and the Mayor's Task Force on Climate Action and Adaptation Planning —appointed 16 months ago as a citizen body to help guide this effort. We are also grateful to the members of the community who attended workshops or provided input through surveys and other formats. All involved have poured many hours of time into creating this Plan. Speaking for the Task Force, who have voluntarily shared these hours, our belief is that combating climate change is the preeminent mission of our time. Columbia, along with the thousands of other cities in the Global Covenant of Mayors, can make a difference. We intended this document to be bold and transformative. If it is judged to fall short of those lofty goals, it should be told that it was not from a lack of effort.

This plan is a start, only a beginning. We hope that it is a strong foundation, but even more, we hope that implementation of this plan begins immediately. With proper implementation, it will quickly evolve and become better, larger, and ever more used as implementation proceeds. When needed changes are discovered and improvements and enhanced targets are created, the Task Force will be the first to applaud their appearance.

The consequences of climate change cannot be understated. The dire implications that are predicted for our future is a clarion call for immediate and sustained action, beginning with leadership at its highest calling.

Sincerely,

Jay Hasheider, Chair

Acknowledgments

We would like to express deep gratitude for those who contributed to the development of this Plan.

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Consulting Team
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And of course, the entire Columbia community!

Executive Summary

The effects of increasing global GHG emissions threaten Columbia's resources and the quality of life for Columbia's residents. Columbia's Climate Action and Adaptation Plan (CAAP) lays out a vision and strategy to address risks posed by climate change and contributes to international efforts to reduce GHG emissions. The **purpose of this plan** is twofold:

1. To prepare Columbia's natural and built environments (neighborhoods, resources, and systems) and people to be more resilient to the impacts of a changing climate.
2. To reduce GHG emissions communitywide, through targeted municipal, residential, industrial and commercial activities.

Developed over a year-long engagement process with the public, the Task Force, and City staff, the Plan focuses on activities that achieve the greatest emission reductions or do the most to increase our community preparedness in the most cost-effective and equitable manner.

Columbia's **vision** is to be the best place for everyone to live, work, learn and play.

The Plan sets specific greenhouse gas **emissions reduction targets**. The City's 80x50 target, an 80% reduction in greenhouse gas emissions by 2050, is broadly accepted by cities, states and nations and prepares the City for carbon neutrality by 2060. The 80x50 target aligns with the Paris Agreement and scientific understanding of the reductions necessary to avoid catastrophic risks of climate change associated with 2.0°C increase in average global temperature.[2]

- **Communitywide Target:** Reduce GHG emissions by 35% below the 2015 baseline by 2035, 80% by 2050 and 100% by 2060.
- **Municipal Operations Target:** Reduce GHG emissions associated with City operations by 50% below the 2015 baseline by 2035 and 100% by 2050.

To achieve this ambitious emissions reduction goal and to adapt to climate change, this Plan includes sector-specific goals, strategies and actions. Successful implementation of these strategies and actions will require continued cooperation and commitment across the community, including the public sector, private sector, residents and businesses.

[2] The City considered using 2010 as a baseline year for consistency with the Intergovernmental Panel on Climate Change (IPCC) Special Report findings, but decided to use 2015 due to data inconsistencies in the 2010 GHG inventory.

Sector-Specific Strategies

Energy

- Increase on-site renewable energy installations in new and existing buildings.
- Maximize Columbia Water & Light's renewable energy purchasing and production.
- Revisit and adjust Columbia's Renewable Energy Ordinance to meet climate goals.
- Create a resilient energy grid.
- Manage energy demand to reduce peak energy use.

Housing, Building and Development

- Increase energy efficiency in residential, commercial, municipal and school buildings.
- Decrease the impact of building stock on local air pollution and greenhouse gas emissions.
- Decrease use of fossil fuels in housing and other buildings.
- Support development of buildings that are resilient to anticipated future conditions.

Transportation

- Prioritize safety and convenience of walking, biking, and riding transit.
- Build a thriving public transit system.
- Create a bikeable and walkable community.
- Shift land use patterns to shorten trips and reduce the need to drive.
- Encourage use of low- to zero-emissions vehicles.
- Reduce use and ownership of personal vehicles.
- Improve efficiency of vehicle traffic.

Waste

- Encourage reuse.
- Reduce landfill waste through customer education, rate structures and increase City recycling programs.
- Expand composting participation and operation.
- Divert construction and demolition waste.
- Require and incentivize recycling.
- Encourage proper disposal of products containing high Global Warming Potential (GWP) gases.
- Upgrade solid waste facilities.
- Track waste diversion.

Health, Safety, and Well-being

- Include vulnerability assessments in planning efforts and enhance communication tools and strategies to prepare the community for anticipated climate change impacts.
- Reduce incidences of heat-related illness and death.
- Prevent and prepare for increased incidence of vector-borne diseases
- Plan for a potential increase in demand for mental health care.
- Increase production of local food.
- Assure food security, particularly among the most vulnerable populations.

Natural Resources

- Increase the accessibility and quality of habitat for native plants and animals.
- Encourage water conservation.
- Improve stormwater management.
- Minimize risks to flood-prone areas.

The Plan also contains an **implementation strategy** that outlines protocols and templates for plan implementation, monitoring and evaluation. An appendix to the final Plan will include a detailed actions list with associated timeframes, responsible parties and next steps, as well as a list of key performance indicators for tracking progress, templates for reporting on indicator and action progress and internal protocols for City implementation.

While there are strong benefits to climate action, there are also areas where climate action goals may conflict with other community priorities. An example is the challenge of infill development for affordable housing needs that potentially decreases natural areas and changes the traditional community character. This Plan seeks to transparently identify these tensions and start discussions about how to both meet the need for climate action and advance other community goals. These tensions points can be found on pages 34, 46, 54, 59, and 64.

To be successful, the CAAP must be an iterative process. This Plan has set goals, strategies and actions. As it is implemented, staff and community will continually evaluate the key performance indicators, calculate environmental and financial impacts and then revise the goals, strategies and actions, as required. Outreach, engagement and education will be required throughout this process to succeed.

BREATHING SLOWLY
by Marissa Moore, Battle High School
Breathing in oxygen.
Breathing out carbon dioxide.

That's how I start my day.
That's how I end my day.
Even when I'm not aware,
Even when I'm asleep,
That's what I'm doing.
That's what we all do.
When you're walking around town,
Driving your car or going to school.

When you're not breathing,
You're holding your breath.
You're in a chemical-filled pool
Or you're trying to take a sip of water.
Maybe it's out of a little plastic straw,
Or a clear bottle from the store.
It doesn't matter too much,
Because in the end…
You'll just throw it away.
It doesn't really matter.
It's just one piece of plastic.

Maybe you'll remember next time,
And it'll all be fine.
Right?
But it won't be.

Because next time,
Even if you remember,
It'll be too much work,
The trash can is closer.
And they're still going to make plastic,
So why does it matter?

Yes, they'll still make plastic,
They will still chop down trees,
The world will always be a bad place
But there will come a day when it's too much to bear

There will come a day
When you're breathing in air,
Nitrogen and Carbon Dioxide,
But not Oxygen this time.

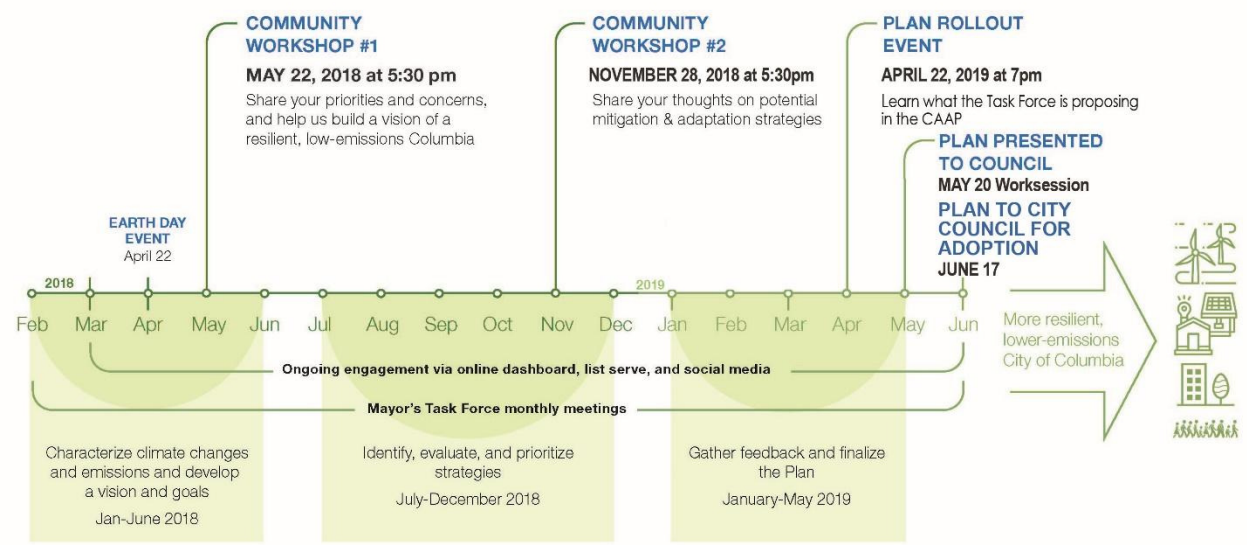
COLUMBIA RENEWED
by Riley Cole, Battle High School
Unforgotten our pollution
From systemic neglect,
Striving for green revolution
Or what had we to protect?
Now sunlight runs the rooftops
And skies sing blue,
Land away from political stops
With all white clouds dancing too.
How have our markets flourished?
A foreigner may contest,
Let the facts be furnished
Lay his eagerness to rest.
Columbia sought its own reason,
Indeed we came together
A host of communal gardens
Dependent on the weather.
Our coal planters unearthed,
But their jobs are not lost,
Into clean careers they've immersed
Without any exhaust.
The target was colossal
With a grand action plan
To never become the fossil
Instead, thrive where we can.
Springs leak into mellow falls,
Breeze slights a wintery glade,
All energy is balanced
As the buoyant seasons wade.

The Youth Advisory Council hosted a creative writing competition in spring 2019. The prompt for the competition was "Write about Climate Action and what 2050 will look like."
The above poems were selected from the Council to be included in the CAAP.

PLAN DEVELOPMENT AND OBJECTIVES

Plan Development Process

This Plan is the product of over a year-long public and stakeholder engagement process that included three community workshops, online public surveys, presentations at board and commission meetings, engagement at community events, collaboration with concurrent planning efforts and close collaboration with the Task Force.



The community workshops provided the public with an opportunity to learn about the planning process, provide feedback on the Plan's vision and strategies, and discuss priorities, challenges and solutions with the project team and other community members. The online public surveys gathered input on issues, ideas, and mitigation and adaptation actions.

The City of Columbia engages in multiple planning processes in the normal course of business. Concurrent to the CAAP process, community input was, and will continue to be, reviewed from the following efforts:

- City of Columbia Strategic Plan
- City of Columbia Vision Zero Plan
- Community Development Consolidated Plan
- Columbia Utilities Integrated Management Plan
- Columbia Utilities Integrated Electric Resource and Master Plan
- CATSO Long Range Transportation Plan
- Columbia / Boone County Public Health & Human Services Community Health Improvement Plan

The project management team for this Plan has incorporated feedback from public and stakeholder engagement processes into this Plan. This reflection respects the conversations our neighbors are having on what makes Columbia the best place to live, work, learn and play—and what opportunities for improvement exist to achieve this vision.

Columbia's Voice: Results from Community Surveys

In fall 2018 and spring 2019, over 900 people responded to online community surveys for the CAAP. Responses from the surveys indicate:

- Strong community support for **immediate action** to reduce greenhouse gas emissions from energy and land use and prepare for a changing climate.
- Strong agreement that Columbia should be a **leader** when it comes to proactively addressing climate change.
- Support for **adoption of the CAAP**, and belief that the plan effectively provides direction to City government and staff on actions to address climate change.
- The top **actions** for addressing climate change include:
  - Designing streets and traffic controls to lower vehicle emissions and support walkability.
  - Replacing the City's vehicle fleet with hybrid and electric vehicles.
  - Offering incentives for energy and water efficiency, solar readiness, and stormwater management that go beyond code.
  - Requiring recycling at multi-family residences.
  - Investing in innovative technologies to enhance renewable energy usage (e.g., energy storage, combined heat and power, microgrids).
  - Aligning the municipal utilities' strategic plans help the community meet climate action objectives.
  - Requiring landlords to manage and mitigate mold and fungus in rental units.
  - Increasing native tree cover on public and private property.
- Preferred **funding strategies** include paying fees associated with specific services, programs or activities and reprioritizing existing resources to pay for climate action.

This final CAAP was revised to reflect feedback received through these surveys, including questions from the public regarding cost, impact and other details of plan implementation.

Climate and Equity

It is important that the CAAP is developed and implemented through an equity lens. Each CAAP action should be implemented in a manner that promotes equity and mitigates structural racism and historic inequality. Providing equitable access to climate action and adaptation benefits requires meeting community needs and implementing measures that address existing vulnerabilities and inequalities. The CAAP will also consider where climate action strategies may lead to adverse, unintended impacts. For example, improving bike lanes and adding open space could spur gentrification and displacement. Similarly, additional City fees and rate increases could add new burdens to low- and fixed-income communities.

Ways to ensure that equity is considered throughout the CAAP implementation process include:

- Designing policies and programs that serve disadvantaged communities first.
- Focusing policies and programs on communities experiencing high pollution burdens, poverty, health issues, and exposure to climate hazards.
- Using an equity checklist when implementing actions. See the example list below.
- Proactively engaging community leaders and members on an ongoing basis.

Below are key equity considerations and questions, drawn from the City of Portland's Climate Action Plan, to consider before implementing climate actions:

- **DISPROPORTIONATE IMPACTS:** Does the proposed action generate burdens (including costs), either directly or indirectly, to communities of color or low-income populations? If yes, are there opportunities to mitigate these impacts?
- **SHARED BENEFITS:** Can the benefits of the proposed action be targeted in progressive ways to reduce historical or current disparities? Are the benefits dispersed not only equally, but equitably?
- **ACCESSIBILITY:** Are the benefits of the proposed action broadly accessible to households and businesses throughout the community, particularly communities of color, low-income populations, Minority-owned, Women-owned and emerging small businesses?
- **ENGAGEMENT:** Does the proposed action engage and empower communities of color and low-income populations in a meaningful, authentic, and culturally appropriate manner? Are community stakeholders involved and engaged in implementation?
- **CAPACITY:** Does the proposed action help build community capacity through funding, an expanded knowledge base or other resources?
- **ALIGNMENT AND PARTNERSHIP:** Does the proposed action align with and support existing communities of color and low-income population priorities, creating an opportunity to leverage resources and build collaborative partnerships?
- **RELATIONSHIP BUILDING:** Does the proposed action help foster the building of effective, long-term relationships and trust between diverse communities and local government?

- **ECONOMIC OPPORTUNITY AND STAFF DIVERSITY:** Does the proposed action support communities of color and low-income populations through workforce development, contracting opportunities or the increased diversity of City and County staff? Does it engage leaders in those communities?
- **ACCOUNTABILITY -** Does the proposed action have appropriate accountability mechanisms to ensure that communities of color, low-income populations, or other vulnerable communities will equitably benefit and not be disproportionately harmed?

Ensuring that participation in climate action is accessible to the entire Columbia community will require consideration of equity in policy, outreach, and infrastructure development. City staff will work to involve diverse community voices from the start of any new initiative and will track progress towards advancing equity.

Equity Actions in the Plan While equity will need to be considered in implementing every strategy and action within this plan, there are particular actions for which equity considerations will be critical, such as:	
I-2.1.4	Develop a process for mitigation, adaptation and climate-equity impact assessments for all new policies and projects that meet threshold criteria, such as cost burden, vulnerability, or increase to net emissions.
I-3.2.1	Create a report that identifies the differential impact of climate change on neighborhoods and communities.
I-3.2.2	Develop and incorporate equity metrics in the evaluation of CAAP activities. This evaluation will be used as a criterion for the CAAP Action Group, Community Climate Commission, and budget team during review of program cost, viability and success.
E-2.1.2	Ensure equitable implementation of grid resilience actions by partnering with vulnerable neighborhoods and non-governmental organizations to develop resilience hubs—community facilities that offer power and other services during times of need. Establish criteria to screen and select locations for community microgrids to support grid and community resilience.
H-1.1.2	Increase energy efficiency funding options for families (low-interest financing, on-bill financing, Pay as You Save, PACE, etc.).
H-1.6.2	Develop affordable and efficient (temporary/transitional) housing options.
T-1.5.4	Preserve and enhance affordable housing as well as infill development, especially near bus service.
HS-1.1.6	Conduct a needs assessment of accessible community centers for extreme weather or other emergency situations. Create a development improvement plan, if needed.
HS-1.2.2	Increase availability to cooling mechanisms in low-income housing and rental units (e.g., air conditioning units, fans, window screens).

Climate Action Targets

City staff and Task Force members worked closely with the Columbia community to set overarching goals for the CAAP. These goals set the foundational framework for the strategies and actions of the CAAP and allow Columbia to track progress on achieving its vision for climate action. The goals below include greenhouse gas reduction targets in line with global scientific, peer-reviewed studies on necessary emissions reductions. To set reduction targets, the Task Force assessed Columbia's forecasted greenhouse gas emissions, listened to public input, reviewed peer cities' targets, and reflected on the community's climate ambitions.

Using the 2015 GHG inventory as a baseline year, the community and municipal reduction targets are:[3]

- **Communitywide GHG emissions**: 35% below the 2015 baseline by 2035, 80% by 2050 and 100% by 2060.
- **Municipal operations GHG emissions**: 50% below the 2015 baseline by 2035 and 100% by 2050.

This 80x50 communitywide target, an 80% reduction in GHG emissions by 2050, is broadly accepted by cities, states and nations and prepares the city for carbon neutrality by 2060. The 80x50 target aligns with the Paris Agreement and scientific understanding of the reductions necessary to avoid catastrophic risks of climate change.[4]

To assess the feasibility of attaining these communitywide targets, the City commissioned the development of a wedge analysis. This forecasting analysis estimates potential GHG emission reductions associated with strategies and actions in the Plan. Wedge analysis findings, presented at the beginning of the "Sector-Specific Strategies and Actions" section, suggest that full implementation of the CAAP will be sufficient to meet the community's near- and long-term GHG emission reduction targets.

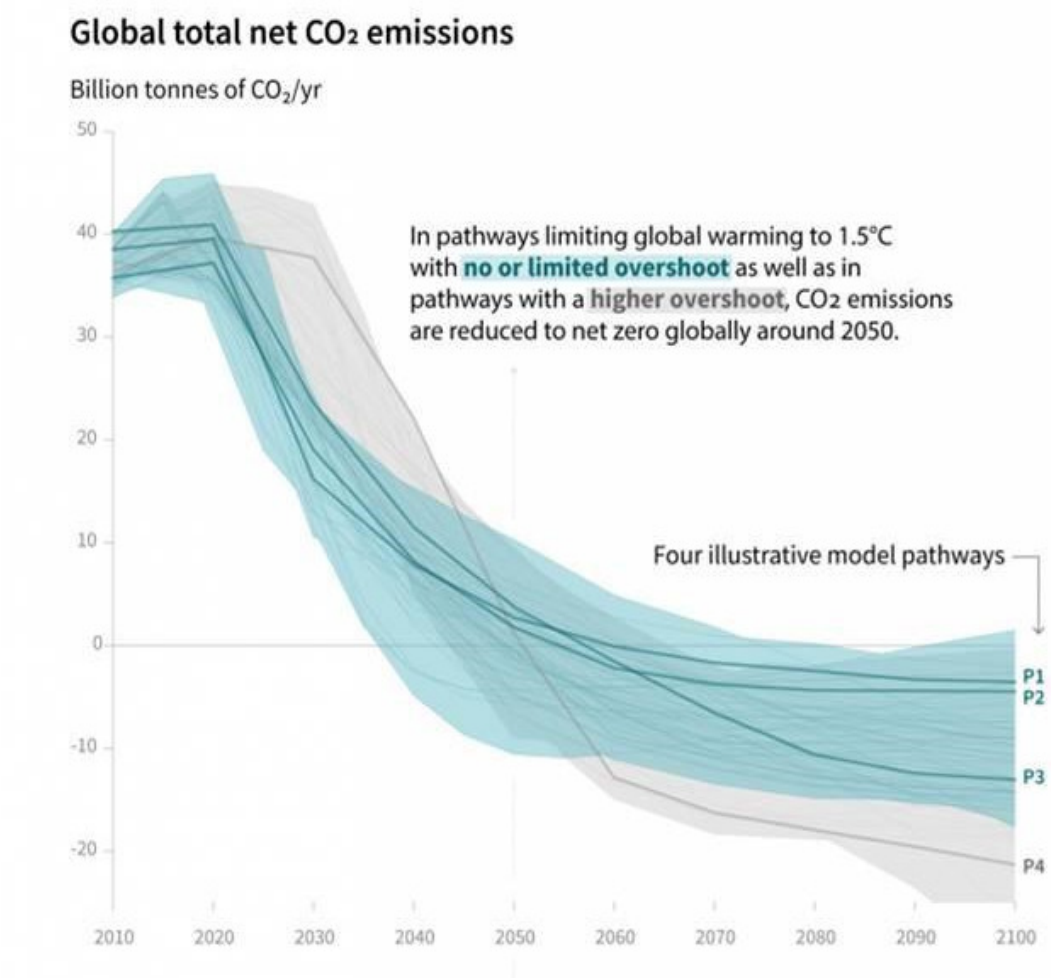
To support achievement of the community's overarching GHG emission reduction goal, and to adapt to climate change, this Plan includes sector-specific goals for climate action. For each emissions or adaptation sector, these overarching goals will guide the implementation of CAAP strategies in support of Columbia's climate vision.

[3] The City considered using 2010 as a baseline year for consistency with the Intergovernmental Panel on Climate Change Special Report findings but decided to use 2015 due to data inconsistencies in the 2010 GHG inventory.

[4] "Framework for Long-Term Deep Carbon Reduction Planning." *Carbon Neutral Cities Alliance*. 2018.

Columbia's Goals and the IPCC

This Plan is intended to allow for course corrections, giving us the ability to address the evolving science of climate change. In 2018, after Columbia had approved its 80x50 goal, the Intergovernmental Panel on Climate Change (IPCC) released a special report that describes the expected impacts of 1.5°C and 2.0°C warming and lays out pathways for limiting average global warming to those levels. As illustrated by the figure below, the report indicates that limiting warming to 1.5°C can only be achieved if action is taken to reduce global carbon dioxide emissions by about 45% from 2010 levels by 2030 and to net zero by around 2050. Limiting warming to 2°C requires net global carbon dioxide emissions to decrease by about 25% from 2010 levels by 2030 and reach net zero by around 2070. We will continue to work to meet the most rapidly attainable emissions reductions.



Source: IPCC Special Report on 1.5°C

Sector-specific goals for climate action

The goals of the CAAP, listed below, address both climate mitigation (reducing greenhouse gas emissions) and climate adaptation (improving resilience to climate impacts) and are denoted as follows:

Mi	Climate mitigation strategy - reduces greenhouse gas emissions
Ad	Climate adaptation strategy - increases resilience to climate impacts
Mi / Ad	Both - addresses both mitigation and adaptation goals

Energy

Mi Increase local renewable energy generation and procure renewable energy.

Ad Maintain reliability of local energy supply and local distribution.

Housing, Building & Development

Mi/Ad Reduce housing-, building-, and development-related energy consumption and improve resiliency.

Transportation

Mi Reduce travel by car.

Mi Reduce greenhouse gas emissions from vehicles.

Waste

Mi Reduce waste production.

Mi Increase waste diversion.

Mi Improve waste system management.

Health, Safety and Well-being

Ad Prepare the community and public safety and health services for anticipated climate change impacts.

Mi Reduce emissions associated with the food system.

Natural Resources

Ad Increase climate resilience and carbon sequestration potential of public and private lands.

Mi/Ad Reduce per capita water usage.

Ad Reduce negative impacts from stormwater runoff and flooding.

WHY ACT?

Taking action to address climate change makes sense for the Columbia community.

To achieve the global GHG emissions reductions needed to prevent significant climate impacts, all cities across the country, including Columbia, will need to do their part to reduce GHG emissions. Cities such as Columbia will also need to prepare for locked-in, inevitable impacts resulting from greenhouse gases already in our atmosphere.

In addition to these needs, many actions to address climate change also contribute to other community priorities and goals. For example, climate action can save community costs from climate-related impacts, improve public health through better air quality and more active lifestyles, and make public spaces more beautiful through tree and native species plantings.

This section provides an overview of what climate change means for the Columbia community. It begins with projections of how climate change will impact Columbia and continues with estimates of the City's annual contribution of carbon pollution to the Earth's atmosphere.

Climate Change and Columbia

Climate change is caused by an increase in the abundance of heat-trapping gases in our atmosphere. Human activities worldwide, primarily the burning of fossil fuels and clearing of forests, have contributed to the increased concentration of these GHGs in the Earth's atmosphere. Increased concentrations of carbon dioxide and the resultant increase in global temperature both contribute to a multitude of cascading impacts from climate change. These impacts include changes in precipitation intensity and frequency, natural animal and plant systems, sea level and disease risk.

Climate change is different from weather. Climate change is a shift in the long-term, average weather patterns. The current, rapid pace of climate change is unprecedented and may exceed many plants' and animals' ability to adapt. Furthermore, each year human activities continue to release GHGs into the atmosphere makes it more difficult to reverse this trend. The rapid rate at which our actions contribute to climate change must be met with an equally urgent and intense effort to reduce emissions and remove GHGs from our atmosphere.

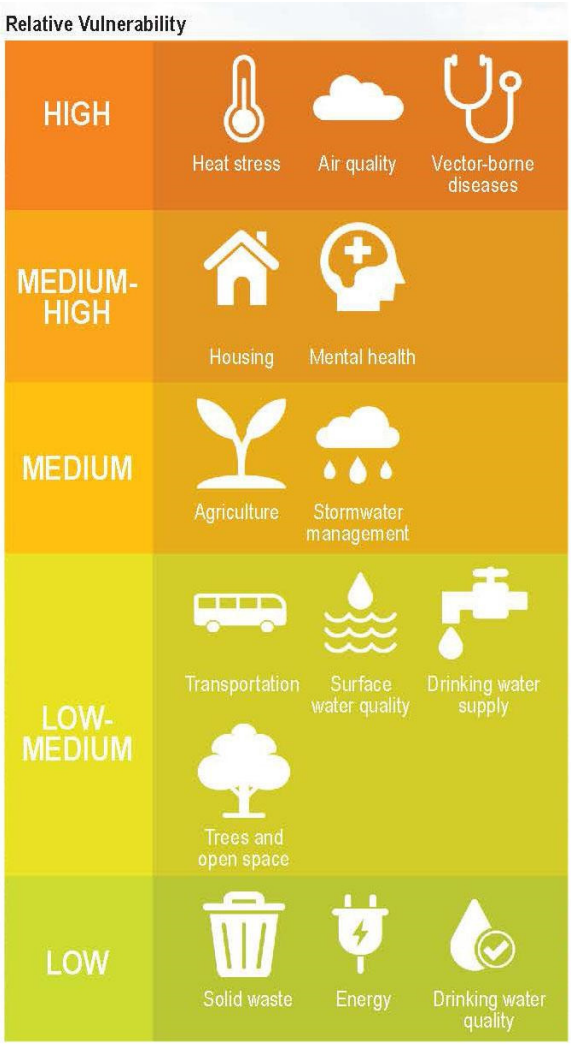
Columbia has already begun to experience the impacts of climate change, and these observed changes are anticipated to worsen over time. Observed and projected future changes in the local climate are summarized below:[5]

[5] Much of the information included in this summary was based on the Climate in the Heartland report analysis, which used historical climate data from the Columbia Regional Airport weather station, 28 National Weather Service cooperative stations across Missouri, and climate change projections completed by Iowa State University scientists based on downscaled data from the international Coupled Model Intercomparison Project 3 (CMIP3) and nine different global climate models

	Observed Changes (since 1889)	Projected Future Conditions (by 2050)
Temperature	+1.3°F increase in average annual temperature	+50 days per year above 95°F
Precipitation	+10% increase in precipitation	+7% increase in average annual rainfall Summer droughts more common
Air Quality	13 days of unhealthy levels between 2012 and 2014	Poor air quality days are more common and severe
Severe Storms and Tornadoes	High tornado activity has occurred earlier in the year	More favorable conditions for storms

Risk and vulnerability

To better understand the extent to which these climate changes will affect Columbia, this Plan includes a climate vulnerability assessment. The vulnerability assessment was conducted with support from the Task Force and City staff and identifies key climate-related risks to Columbia's resources.



The vulnerability assessment assigns vulnerability rankings to key systems within the Columbia community (see figure), taking into account three key factors in relation to anticipated climate change impacts:

- **EXPOSURE**: The number of people and value of assets in harm's way or at risk due to their physical location.
- **SENSITIVITY:** The severity of the consequences of being exposed to these risks and the degree to which climate change exacerbates existing stressors.
- **ADAPTIVE CAPACITY:** Steps the City and community are already taking to prepare for climate change impacts and whether they have existing capacity to accelerate and/or expand those efforts, if needed.

A summary of the impacts of climate change to populations, regions or infrastructure that are especially vulnerable within the following focus areas:

- Health, safety and well-being
- Open space and agriculture
- Water supply and quality

Full vulnerability assessment findings are provided in the Appendix.

Health, Safety and Well-being

The areas of particular concern in this sector are an increase in days with poor air quality and greater exposure to allergens, heat-related illness and vector-borne diseases. Another concern often not immediately recognized is the effect of changing environmental conditions on our community's mental health. The actual impacts of climate change, and even the potential for their occurence, can lead to negative impacts on mental health. Long-

term changes to weather patterns and extreme events also affect food prices as well as safety and property concerns associated with flash flooding.

Open Space, Street Trees, and Agriculture

The effects of warming climate conditions, higher temperatures, high rainfall events and drought, expose our existing natural habitats and agricultural crops to more stressful conditions, higher incidence of pests, diseases, and invasive vegetation. While changes to conditions may also bring a longer planting window and growing season, the impacts of extreme conditions may outweigh those benefits.

Drinking Water Supply and Surface Water Quality

Warming temperatures, increasing drought and other changes in precipitation may limit water resources and increase demand. Columbia's water supply is likely sufficient to meet demands even under future conditions. In addition to public education, investments are currently being made to ensure and expand sufficient water infrastructure. The quality of the water in our streams and lakes will likely be negatively impacted by more frequent and heavier rain events when untreated stormwater increases pollutant concentrations. Heavier rain events may also erode stream banks, which increases sediment and degrades aquatic habitats.

Actions our community are currently taking to address some of the issues above appear on pages 28-29.

The Social Cost of Carbon Pollution

Social, environmental and economic costs of climate change, largely due to burning fossil fuels, are not included in the price we pay for the fuels themselves. Burning fossil fuels results in economic consequences, such as infrastructure damage from flooding, fires or extreme storms. Despite the very real nature of these costs, the market price of fossil fuels does not include these societal cost externalities.

Identifying the true social costs of burning fossil fuels can help policymakers decide if investments in climate action are cost effective. Researchers, including those at the U.S. Environmental Protection Agency (EPA), have worked to quantify the economic losses associated with each metric ton of carbon dioxide burned. This is called the Social Cost of Carbon.

The EPA estimates a range of possible social costs of carbon depending on the year and discount rate applied to the future. These estimates range from $36 per metric ton of carbon dioxide equivalent ($MTCO_2e$) in 2015 to $69 per $MTCO_2e$ in 2050.[6] However, the EPA acknowledges that current modeling does not include all important damages—estimates by other agencies and researchers are far higher. Some recent estimates have determined the social cost of carbon could be as high as $100-$200 per $MTCO_2e$.[7]

To reach Columbia's 2050 goal, the community will need to reduce emissions by 2.3 million $MTCO_2e$ compared to the business-as-usual scenario. Using the 2050 estimated social cost of carbon of $69 per $MTCO_2e$, achieving this reduction would equate to $158 million in avoided societal costs.

[6] "The Social Cost of Carbon." 2017.

[7] Nuccitelli, Dana. "Republican hearing calls for a lower carbon pollution price. It should be much higher." *The Guardian*. 1 March 2017. www.theguardian.com/environment/climate-consensus-97-per-cent/2017/mar/01/republican-hearing-calls-for-a-lower-carbon-pollution-price-it-should-be-much-higher . Accessed 3 July 2017.

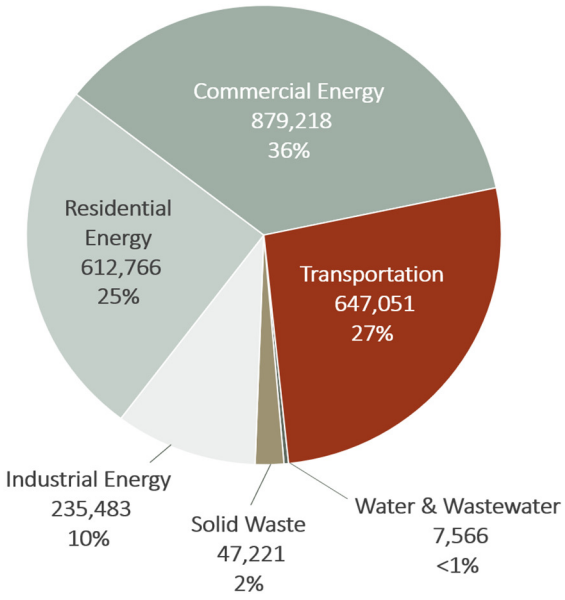
Columbia's contributions to climate change

Columbia has been reporting its community GHG emissions every five years since 2000 and recently completed its first GHG inventory of municipal operations. Activities that result in the release of GHG emissions include burning fossil fuels for transportation and energy, disposing of waste in landfills and treating wastewater. From 2000 to 2015, community GHG emissions increased by 12%, to 2.8 million $MTCO_2e$ in 2015. However, per capita emissions decreased over that time period by 20% to 20.5 $MTCO_2e$/person. The first municipal GHG inventory found that municipal operations resulted in the release of 68,252 $MTCO_2e$ in 2015.

Community Emissions Profile

The community emissions inventory accounts for the emissions associated with activity within Columbia. When residents burn fossil fuels within the city, by driving cars and burning natural gas to heat homes, those emissions count towards the inventory. Sources of GHG emissions from the Columbia community include commercial, residential, industrial, transportation, building and waste sectors.

- The **residential** sector includes single and multi-family homes.
- The **commercial** sector includes most businesses and institutions, including retailers, office space, government operations and universities.
- The **industrial** sector includes facilities that host industrial processes, including energy generation facilities.

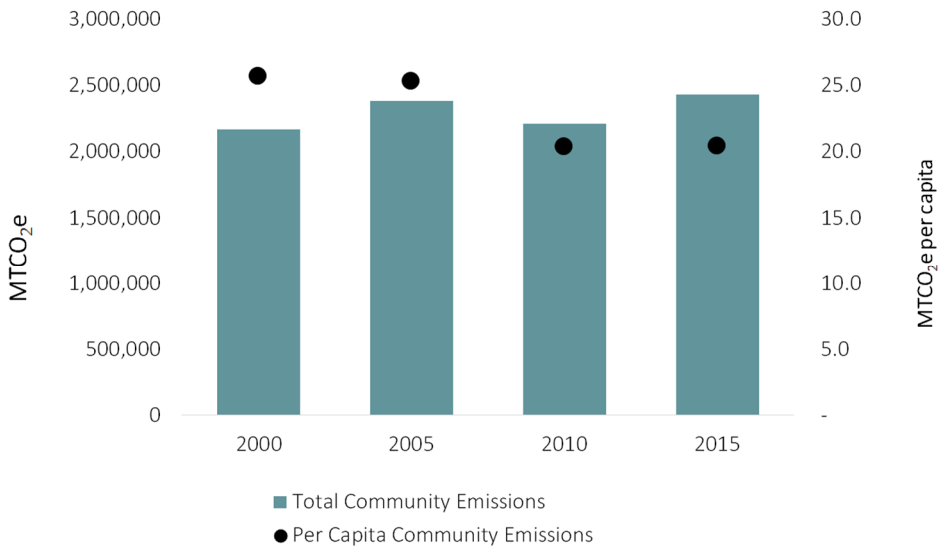


When residents and businesses consume electricity, the inventory counts emissions associated with the production of electricity, even if those emissions occur outside city boundaries. In 2015, Columbia's total GHG emissions were 2,429,305 $MTCO_2e$ in 2015. It would take over 3 million acres of new forest to sequester this much carbon in one year.[8]

Over time, total community emissions have increased by 12%, but per capita emissions have decreased. In 2015, per capita emissions were 20.5 $MTCO_2e$/person, down from 25.7 $MTCO_2e$/person in 2000.

Caption: Sources of communitywide GHG emissions in Columbia include transportation, residential, commercial, and industrial energy, and waste (in $MTCO_2e$, for 2015).

[8] "Greenhouse Gas Equivalencies Calculator." United States Environmental Protection Agency. December 2018. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator



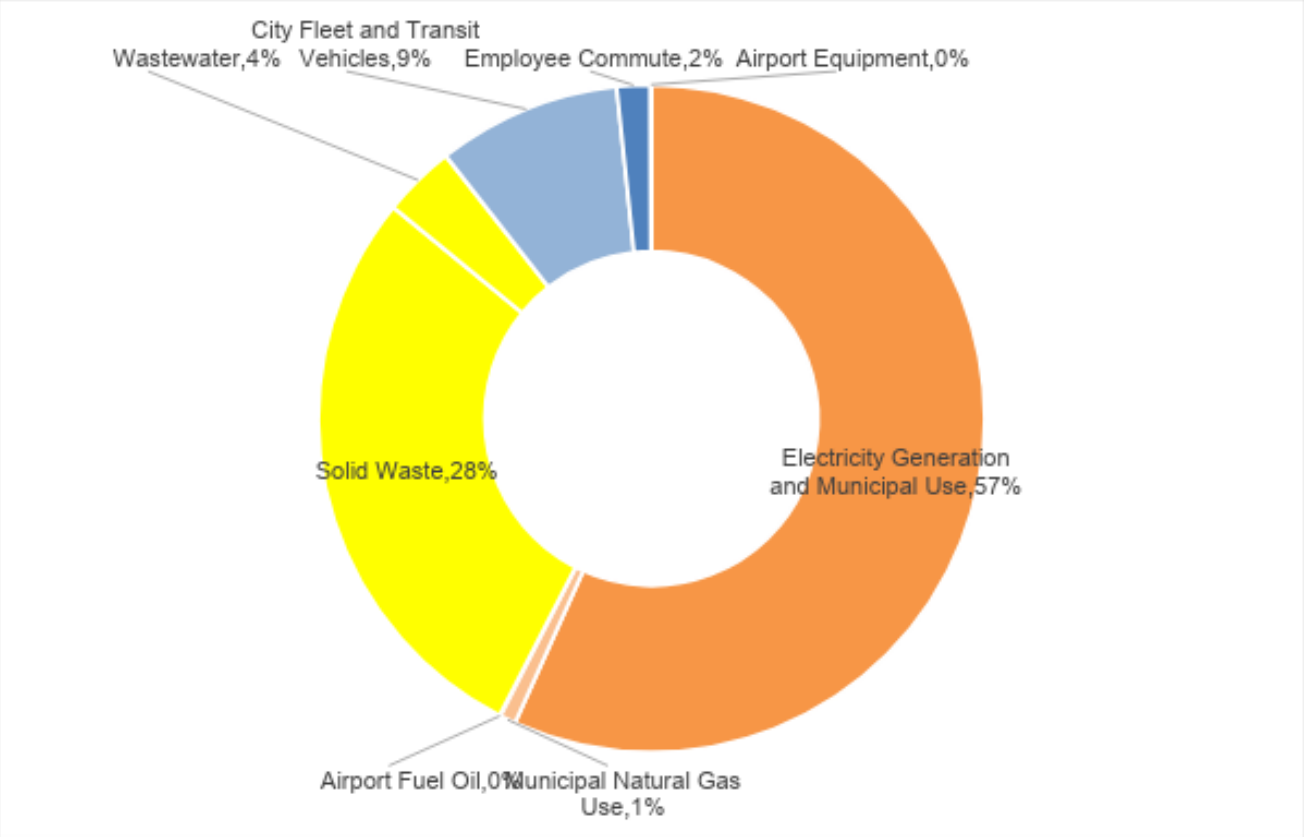
Caption: Total community-wide greenhouse GHG in Columbia have fluctuated over time, while per-capita emissions have largely decreased.

Electricity emissions are the single largest source of emissions for Columbia. Three utilities provide electric power to the community: Columbia Water & Light, University of Missouri Columbia Power Plant and Boone Electric Cooperative. In order to serve their customers' needs, each has both local generation facilities and purchases power from remote production facilities.

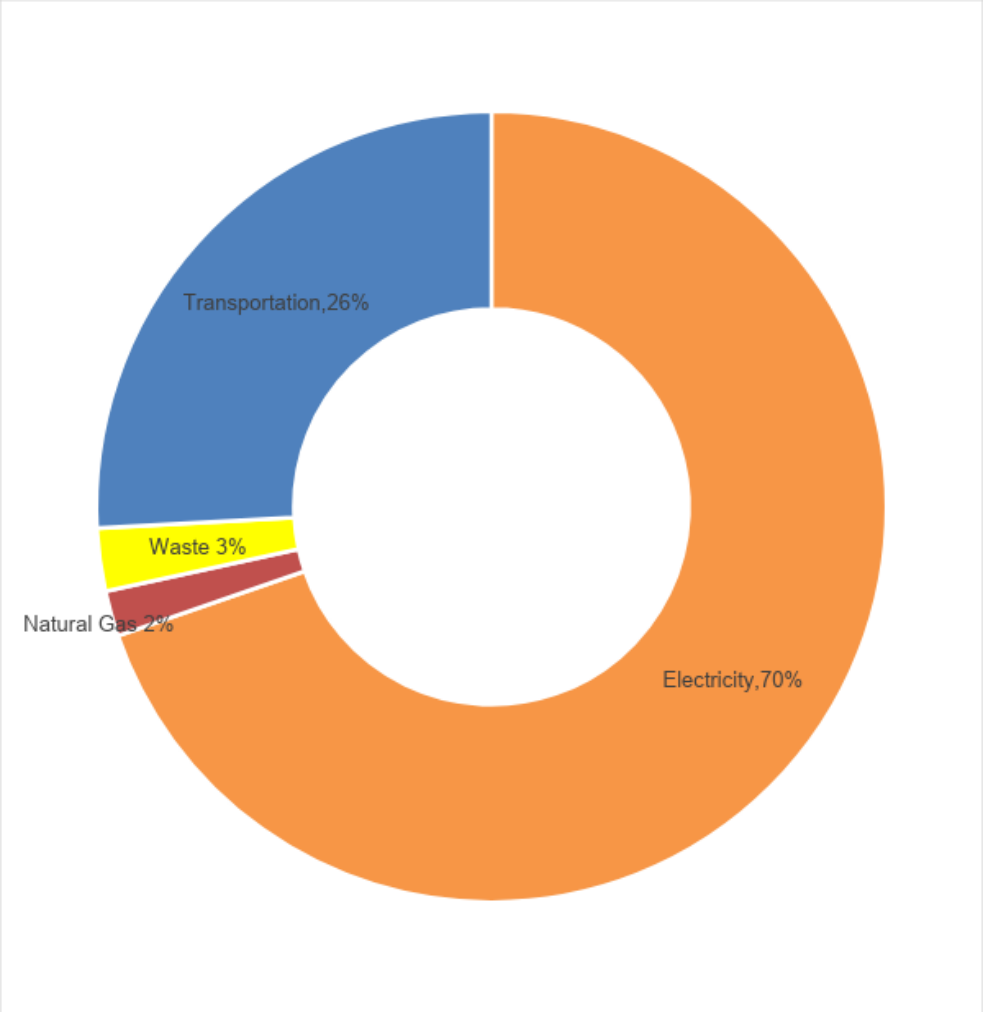
Municipal Emissions Profile

As a part of the development of this Plan, a municipal emissions inventory was completed to account for the impact of the full range of utilities and other services provided to the community by the City (e.g., solid waste, water and wastewater treatment, public transportation and electricity), as well as the impact of day-to-day operations as an organization. Energy emissions include those from 1) electricity generated locally by the City of Columbia as well as the electricity used for City operations and generated elsewhere, 2) natural gas used at City facilities, and 3) fuel oil used for heating at the airport. Energy emissions total 92,821 $MTCO_2e$, 58% of the 2015 municipal inventory. Emissions associated with landfill operations and wastewater treatment total to 53,072 $MTCO_2e$ (31%).GHGs associated with the operation of City fleet and transit vehicles, City employee commuting and ground equipment at the airport total 17,630 $MTCO_2e$, 11% of the total emissions. Reporting total emissions from these sources is important and will continue to inform broader process changes and our progress toward meeting community emissions reduction goals.

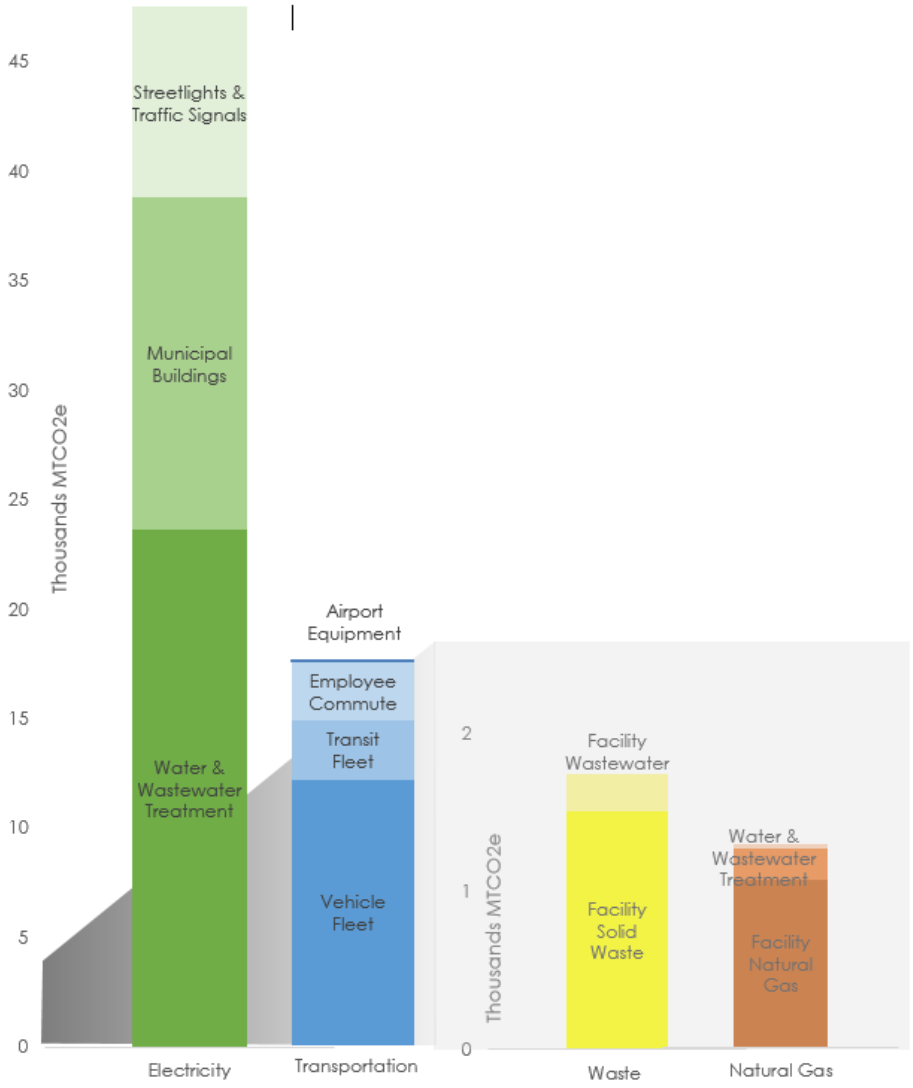
Caption: Sources of greenhouse gas emissions from City of Columbia operations including community utility use (2015, total = 163,523 $MTCO_2e$). Emissions from airport ground equipment and fuel oil use (0.05% and 0.06% respectively) are not labeled here for clarity.



The chart below removes the emissions impact of providing utility services to the community at large. Instead, it represents the emissions impact of day-to-day operations of the City of Columbia as an organization. Progress toward the municipal emissions reduction goals of 50% by 2035 and 100% by 2050 will be measured using the accounting represented below.



Caption: Sources of GHG emissions from City of Columbia operations excluding community Utility use (2015, total = 68,252 $MTCO_2e$).



Caption: Detailed contribution of business activities to municipal emissions (2015, total = 68,252 MtCO2e). Emissions from fuel oil use at the airport (96 $MTCO_2e$) are not included here for clarity.

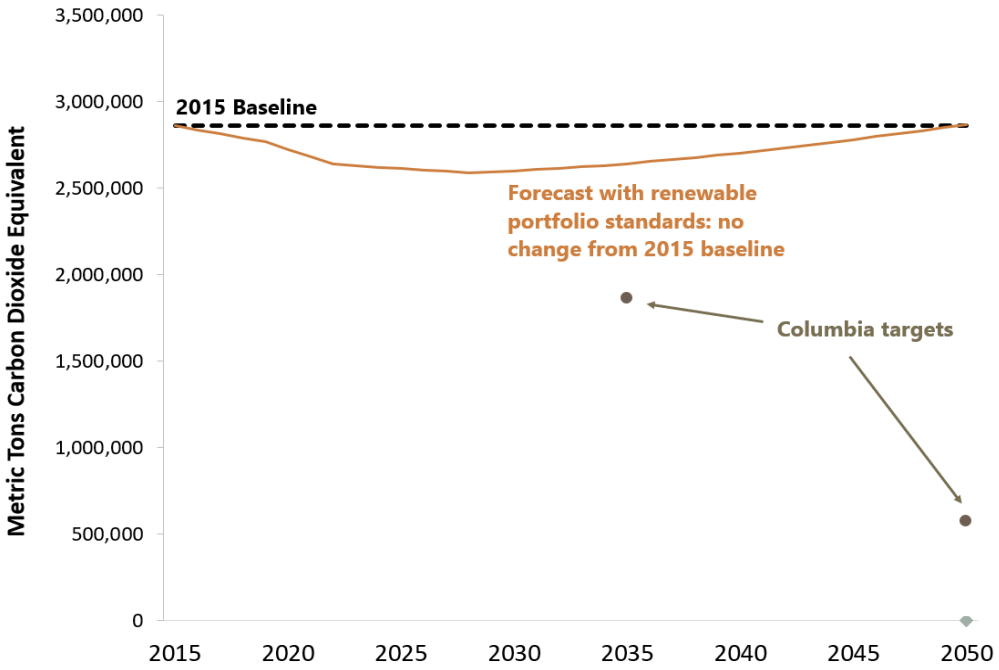
How will emissions change in the future?

A business-as-usual forecast provides an estimate of potential future emissions, assuming that the City takes no further action. It considers the influence of external factors on Columbia's emissions, such as population growth, changes in the regional electricity fuel mix, and energy demand.

The business-as-usual forecast for Columbia is presented below. The following key assumptions for Columbia's business-as-usual forecast were refined in consultation with the Task Force and City staff:

- 1.3% annual employment growth rate from the CATSO-County-City Employment Projections 2050.
- 1.5% annual population growth rate from the CATSO-County-City Employment Projections 2050.
- Reductions in personal vehicle carbon intensity factors based on CAFE standards.
- Energy demand projected linearly based on 2012-2017 electricity demand.[9]
- The City meets its renewable portfolio standards (RPS): 15% renewable energy by 2017, 25% by 2022, and 30% by 2028.

The forecast estimates that Columbia's overall emissions will be roughly the same in 2050 as they are in the baseline year, 2015. This scenario conveys the need for ambitious climate action to meet the City's short- and long-term emission reduction goals. The goals needed to curb the increase in average global temperature to 1.5°C is also provided for context.[10]



[9] This energy demand forecast does not take into account anticipated future demand from electric vehicles.

[10] Source: IPCC Special Report on 1.5℃ (2018)

PROGRESS TO DATE AND CONCURRENT EFFORTS

Existing Climate Efforts

Columbia is already taking initiative to mitigate its climate impact and promote community wellbeing. Columbia's City Council and staff worked to create sustainability programs for the community, adopted building codes and policies to support climate change action, and improved municipal operations. To date, the City has taken the following steps, organized by sector.

Climate

- Endorsed the U.S. Conference of Mayors Climate Protection Agreement.
- Established the Mayor's Climate Protection Awards to recognize local businesses and organizations that promote sustainability.
- Formed a Mayor's Task Force to guide development of the CAAP.

Health, Safety and Well-being

- Advocates for local, healthy food production.
- Partners with regional emergency responders on preparedness planning.
- Created nine public warming/cooling centers.
- Participates in the Voluntary Action Center's Air Conditioner Exchange and Summer Fan programs.
- Collaborated to create an Agriculture Park.

Energy

- Adopted Renewable Energy Standard ordinances that require an increasing percentage of electricity to be generated with renewable sources.
- Provides solar photovoltaic rebates and loans for customers.
- Has entered into 10MW solar power purchase agreement.
- Operates landfill gas to energy plant at the municipal landfill.

Transportation

- Provides Go COMO bus services.
- Uses compressed natural gas and electric vehicles.
- Updated building and zoning codes.
- Adopted Vision Zero to make Columbia's roads safer.
- Efforts of GetAbout Columbia's to improve walking and biking opportunities.
- Implements Columbia Imagined.
- Maintains and builds trails systems connecting residents, including the development of a 30-mile loop.

Waste

- Provides waste audits and consulting.
- Maintains a bioreactor landfill/bioenergy plant.
- Provides yard waste and recycling drop-off centers.
- Manages household hazardous waste and paint for reuse.

- Provides waste education through public events, the recycling ambassadors program, compost workshops, the CoMo Recycle and Trash app and Waste Wizard.
- Runs programs to properly dispose of waste through drug takeback, e-waste, tire collection, fix-it fairs and commercial food waste recycling.

Housing and Buildings

- Provides energy efficiency incentives, energy loans, and rebates to residential and commercial customers.
- Created the Community Land Trust Lynn Street Cottages.
- Runs buyout programs for homes in floodplains.
- Provides home repair and rehabilitation funds to low- and moderate-income families.

Natural Resources

- Conducts habitat restoration projects.
- Manages native pollinator gardens.
- Uses native plants to landscape roundabouts, medians, and along roads .
- Adopted the Emerald Ash Borer Management Plan to prepare for infestation.
- Purchases land and creating parks so that no one is more than two miles from recreational green space.

Water Supply and Quality

- Proposed water treatment plant upgrades.
- Inspects and maintains hundreds of stormwater treatment and control structures.
- Sells rain barrels and provides homeowners with native, low-input landscaping assistance.
- Created backup storage of water for emergencies.
- Adopted stormwater management program and plan.

Education and Outreach activities and programs include:

- Recycling Ambassadors
- Tree Keepers
- Stream Team
- Composting workshops and community gardens
- Energy and water conservation education
- Classroom and school waste audits
- Native plant education
- Fix-it fairs
- Bicycle safety classes and repair co-op

MOVING THIS PLAN FORWARD – IMPLEMENTATION STRATEGY

Implementing the CAAP requires motivating staff, finding funding for strategies, involving community members to make key changes, and sustaining momentum. Columbia has already taken steps to improve community sustainability. The following implementation strategies build on those efforts to ensure the CAAP strategies are completed. This section of the plan includes:

- A **timeline** for taking action, including projects that could be started tomorrow as well as transformations that will happen over the long term.
- A plan for **sustaining community, government and stakeholder buy-in**. Making progress on climate action requires leadership and commitment from the city government and from the community. Community engagement has been a vital part of the CAAP development process and sustained community support is going to be equally important moving forward.
- A **structure for ongoing monitoring, evaluation and reporting** on CAAP progress. Investing in data collection and consistent reporting is a key aspect of implementation. City staff will track and regularly report on CAAP indicators, GHG emissions and notable progress on implementing strategies. Evaluation of progress will include revisiting project priorities based on new information regarding action need, effectiveness, feasibility and cost.

Levers for Affecting Change

Development of the actions in this Plan required identification of appropriate levers, or mechanisms, for affecting change. These levers represent tools within the City and community's toolbox for taking action. Levers can take the form of carrots (voluntary incentives to encourage desirable behaviors) or sticks (mandatory instruments to discourage undesirable behaviors). The planning team identified the most appropriate levers for each goal and strategy during the strategy evaluation process (see Plan Development Process section for more information). This Plan includes a mix of both carrots and sticks. During the implementation phase, carrots may be prioritized first to gauge effectiveness before introducing needed sticks to reach goals.

Potential levers and their definitions are listed below:

- **Policy:** Introduction of new or revised formal policies that delineate guidance, requirements, or specifications.
- **Capital Infrastructure Project (CIP):** Development of, or changes to, physical structures or systems.
- **Monetary Instrument:** Introduction or adjustment of monetary mechanisms for encouraging target behaviors, such as rebates, subsidies, loan programs or taxes.
- **Information/Education:** Development and distribution of informational materials, implementation of education, outreach, or technical assistance programs, or conducting a study.
- **Partnership/Collaboration:** Building or fostering key partnerships or collaborations that could support learning or synergistic action.
- **Management Practice:** Informal adjustment of ongoing operations, processes or practices.

Examples of actions in the plan for each of the above levers include:

Lever Type	Example Action	
Policy	HS-1.3.1	Create anti-idling policies and enforcement plans.
Capital Infrastructure Project	E-1.1.3	Install solar panels on all City buildings and sites, where feasible.
Monetary Instrument	H-1.1.2	Increase energy efficiency funding options for families (low-interest financing, on-bill financing, Pay As You Save, PACE, etc.).
Information/ Education	W-2.2.1	Study the short- and long-term cost/benefit of a City composting program.
Partnership/ Collaboration	T-1.5.5	Partner with Columbia Public Schools to adjust school siting requirements to prioritize building schools in walkable and bikeable areas.
Management Practice	I-2.1.1	Hold biannual meetings with all division heads to highlight progress, plans and challenges related to projects with climate impacts.

In some cases, levers were not identified for actions. Reasons could include uncertainty regarding the most effective lever or need for further research. In those cases, it is envisioned that definition of these levers and other additional specifications would be developed during the plan implementation phase.

Timeline for Implementation

Climate actions build on each other and all require community, staff, and elected officials' support. A specific overview of year one implementation is outlined below, followed by a broader priority action list for initial implementation. Implementation details for all priority strategies and actions in the plan are provided in Appendix A (to be released with the final plan).

Year One Implementation Overview

The initial focus will be on forming the foundation for ongoing action by creating institutional accountability and maintaining public support. Year one actions include:

- Create **Community Climate Commission** to advise staff on the implementation of the CAAP.
- Ensure the critical functions of the Plan are adequately staffed and supported.
- Identify opportunities for, and barriers to, the **equitable implementation** of CAAP strategies.
- Form an internal **CAAP Action Group** with representatives from across City departments tasked with short- and medium-range planning of CAAP implementation activities.
- Create a **data management and reporting system** for key performance indicators of activities related to CAAP goals.
- Include a report in the **City Manager's proposed budget** on the existing and proposed projects that improve mitigation and adaptation efforts.
- Develop specific **funding options** for CAAP priorities.

A Comprehensive, Phased Approach: Priority Early Actions

Many strategies and actions in this plan are interrelated. For example, actions to clean the electricity grid will make the transition to electric vehicles more impactful. The planning team considered these interrelationships in designing a phased approach to plan implementation. The following actions would be prioritized early in CAAP implementation to set the City up for success in achieving long-term goals:

- **CLEAN FUEL FOUNDATION:** Behavior change is hard and takes time to achieve. Efforts to change our community driving habits, car purchasing decisions, and home and business energy consumption requires careful planning, time-intensive policy development and resource-intensive programming—often with unknown outcomes. Given this uncertainty and the sometimes slow-developing results, focusing on establishing a clean, affordable and renewable electricity source as a first phase of CAAP implementation directly addresses over 60% of our total community emissions. Achieving 100% renewable electricity will leverage the impact of actions requiring a shift from fossil fuels to electricity (e.g., gasoline to electric vehicles), making them more impactful and attractive. This approach also builds on the existing renewable energy goals of our municipal electricity utility, Water & Light. Furthermore, pathways toward achieving 100% renewable electricity such as community solar and renewable energy credits (RECs) are well-established approaches and could be emulated from other utilities across the country. Prioritizing these clean fuel actions will provide an important and viable early success for the CAAP that can help energize the community and facilitate achievement of the City's near-term emission reduction goals. However, this initial focus does not mean that the City should not start on other infrastructure or behavior change actions in the Plan as well. A balanced, mixed portfolio of actions will be important for successful, comprehensive plan implementation.
- **FUEL SWITCHING:** With a 100% renewable electricity pathway identified and underway, we can begin shifting focus to fuel switching. Specifically, prioritizing a transition of our residential and business energy use in transportation and buildings from fossil fuels to renewably generated electricity. This includes actions to transition fuels used for space and water heating in buildings to renewable electricity as well as requiring or encouraging electric passenger vehicle adoption. We see this path as a viable option for Columbia, as the current high dependency on single-occupancy vehicles is unlikely to change dramatically in the near-term, and purchasing decisions made now will have lasting impacts. For example, the average U.S. household replaces vehicles only every 10 years, so actions taken now may not realize their full potential until 2030 at the earliest. Continued improvements to our existing transit, biking and walking infrastructure will also be a key element in reducing our transportation emissions. Reducing reliance on fossil fuels also brings economic, public health and resilience benefits, as consumers are no longer subject to price fluctuations in natural gas and petroleum markets, and local air pollution from internal combustion engines is eliminated.
- **AFFORDABLE DENSITY:** Actions to prepare for and increase density bring a host of benefits to a community. When people live closer together, the average size of living and work space declines, heating and cooling costs go down, the need for individual vehicles is reduced, and travel distances decline. Increasing density would also require new construction in Columbia, presenting an opportunity to incorporate energy efficient technologies from the start. Dense communities can create other opportunities for climate mitigation and adaptation, such as eco-districts, avoided development of important natural areas and habitats, and increased social cohesion and resilience. It will be important to create density in a manner that does not conflict with other adaptation and equity goals. For example, optimizing green space and tree canopy cover to provide carbon sequestration, shade and habitat.

Sustaining Community Support

Throughout the CAAP development process, **public input** has been essential to informing CAAP priorities. Moving forward, individual actions will be necessary to meet City emission reduction targets. The City will continue to foster conversations on climate change and climate leadership through public engagement by partnering with existing community groups, neighborhoods, and business groups in climate action. In addition to informing CAAP priorities, public input throughout the CAAP development has also fostered numerous education programs and outreach ideas that will be developed and promoted as the Plan is implemented. These ideas range from public service campaigns around the importance of properly inflated tires for vehicle efficiency to including GHG emissions information on utility bills.

To formally maintain public participation in CAAP implementation, CAAP strategies include creating a **Community Climate Commission**. This commission will advise staff, maintain community engagement, and provide accountability.

Additionally, strengthening **City staff capacity** and knowledge will help maximize the speed and impact of CAAP implementation. Internal staff development can include workshops on climate change, support for strategy implementation and development of CAAP planning metrics.

Balancing Funding Needs and Community Priorities

Funding and resources are tight for the City of Columbia and for most local governments. Anytime council, staff or citizens bring forward new programs and projects we must answer the fundamental question, “How can we pay for this?” It is a fair and important question and ultimately reflects the values and priorities of the community. The actions outlined in this Plan are no exception. How do we reprioritize, find new resources, and rethink funding mechanisms without dropping other community priorities?

There is $435 million requested for projects in the FY2020 Capital Improvement Plan with few of the projects funded at any given time. Every ballot, bond issue and budget requires rigorous prioritization by staff, council and citizens. Master plans, strategic plans, engineering assessments, customer satisfaction, and a host of other data sources and plans help guide project prioritization. Reaching the goals adopted by the community in this plan will require reexamining those projects for ones that help, ones that can be changed, and ones that hinder. Every project and program is important to someone, and reprioritization ultimately requires addressing and adjusting expectations.

Some of the actions in this plan may be funded by increasing existing revenue sources or creating new ones. This requires the City as an organization and a community to find answers to important questions: How do we structure taxes, fees and rates so that they are fair and equitable? Should increases be applied across the board or be tied to usage and impact? Changes to funding are fraught with controversy and will likely present the risk of a new burden to some segment of the population.

One way to improve efficiency is through communication among City employees. To do this, we must first remove barriers between departments. We use the term “breaking down silos.” When silos exist in organizations and communities, progress on shared issues can suffer and become needlessly expensive. Social justice, affordable housing, economic development, public safety, non-motorized transportation, and climate action are all priorities with a great deal of overlap and can suffer from siloing. The implementation strategies and actions on pages set the groundwork for breaking down silos. The CAAP offers cross-priority actions that can help us achieve outcomes across a wide array of priorities. The challenge will be focusing on the desired outcomes from an organizational perspective, instead of a single, siloed priority area. The actions in this plan can be implemented with the right mix of prioritization, raising of new funds and a rethinking of how we achieve the priorities we set for our City.

Monitoring and Evaluation

City staff will conduct ongoing monitoring, evaluation, and reporting on CAAP progress. This section outlines a high-level plan for these activities. Key aspects of monitoring and evaluation include:

- **Conducting annual GHG inventories** and report results to City Council. GHG inventories inform progress towards meeting reduction targets and highlight areas that need additional action.
- **Establishing performance metrics and a tracking structure** for monitoring progress within City departments. Monitoring key performance indicators (KPIs) will help track progress on individual CAAP actions. A list of all KPIs will be provided in an appendix of the final plan.
- **Evaluating and reporting progress.** Reporting the status of CAAP implementation to City Council annually will ensure there is consistent progress. It is important to spread out actions over many years so that CAAP strategies can build on one another.
- **Adapting strategies and actions.** The results of the GHG monitoring and evaluation of actions using key performance indicators will be used to update the CAAP as necessary to meet CAAP goals.

What will be tracked?

Two primary elements of the CAAP will be monitored:

- **Action progress:** More qualitative descriptions of progress the City is making toward implementation of actions in the plan.
- **Key performance indicators:** quantitative metrics that indicate progress towards higher-level goals and target outcomes of the plan.

Where will indicators be tracked and reported?

City staff will calculate and track all indicators. Key indicators will be publicly viewable on the online CAAP dashboard.

City staff will develop annual progress reports for City Council and the public. Progress reports will include a detailed appendix with all indicators and action-by-action progress.

Who will track indicators?

City staff will be responsible for calculating and reporting on indicators.

How often will CAAP indicators be updated?

The majority of indicators will be updated annually. Some indicators may be updated less frequently depending on how often new data is available.

What is the process for reviewing indicator progress?

The City will hold annual division-level meetings to identify goals, review progress, and identify course corrections and next steps. A dedicated group within the City, including Sustainability staff, will develop work plans from division-level outcomes.

How often will the CAAP be updated?

This CAAP was designed to be a living document. The CAAP, including targets and goals, will be updated every five years. The strategies and actions in this foundational CAAP reflect the latest available technologies and best practices in the climate action and adaptation field. However, to continue meeting the goals of this Plan effectively, the Columbia community must have the ability to adapt as new technologies change and best practices evolve. The ongoing monitoring and evaluation practices described in this section will reveal what is working, what is not working and what course corrections may be warranted. Updating the CAAP every five years will allow Columbia to adaptively manage its climate actions and ensure that the plan continues to optimally serve the community.

Cross-Cutting Strategies and Actions

Goal I-1. Establish climate action as a priority for the City Council and the community.

Strategy I-1.1: Include CAAP objectives in Council priorities.	
I-1.1.1	Use recommendations in the annual report to identify budgetary priorities that support implementation of the CAAP.
I-1.1.2	Identify State and Federal legislative issues that support the goals of the CAAP and enable its implementation.
Strategy 1.2: Utilize Community Climate Commission to support accountability, implementation, and awareness of the CAAP in the community.	
I-1.2.1	Create Community Climate Commission to advise staff on the implementation of the CAAP. The Commission will represent the diversity of the community with relevant expertise in the social, scientific, economic and environmental components of CAAP strategies.
I-1.2.2	Advise staff in the preparation of an annual CAAP progress report and recommendations for City Council.
I-1.2.3	Present annual CAAP progress report policy and budget priorities to City Council for acceptance.
I-1.2.4	Identify opportunities and barriers to equitable implementation of CAAP strategies.

Goal I-2. Establish CAAP goals as priorities in the activities of the City of Columbia as an organization.

Strategy I-2.1: Support integration of climate goals in all Divisions.	
I-2.1.1	Hold biannual meetings with all division heads to highlight progress, plans and challenges related to projects with climate impacts.
I-2.1.2	Form a CAAP Action Group with representatives from across departments tasked with short- and medium-range planning of CAAP implementation activities.
I-2.1.3	Develop a decision matrix to be used to integrate mitigation and adaptation priorities into City planning and standards (zoning, construction standards, CIP review). City departments will utilize forecasted model data (climate, health, population, economic, etc.) during these processes, where available.
I-2.1.4	Develop a process for requiring mitigation, adaptation and climate-equity impact assessments for all new policies and projects that meet threshold criteria, such as cost burden, vulnerability or increase to net emissions.
Strategy I-2.2: Incorporate CAAP goals into the budget process.	
I-2.2.1	Integrate annual CAAP report goals during the budget review process at the direction of the City Manager.
I-2.2.2	Include a report in the City Manager's proposed budget on the existing and proposed projects that improve mitigation and adaptation efforts.
I-2.2.3	Assessment of progress toward CAAP goals shall be included in the City Manager's annual performance review by the City Council.

Goal I-3. Strengthen City capacity to support community climate action.

Strategy I-3.1: Improve City staff capacity and knowledge of their role in meeting climate goals.	
I-3.1.1	Create a data management and reporting system for key performance indicators of activities related to CAAP goals.
I-3.1.2	Create and distribute an annual municipal adaptation and GHG emissions report to staff to be used in assessment of current and proposed activities.
I-3.1.3	Conduct annual GHG emissions inventories, including identification of improved processes for quantifying net carbon sequestration and solid waste emissions.
I-3.1.4	Continue to align performance measurements of CAAP actions with existing planning metrics.
I-3.1.5	Provide training and other capacity building opportunities to staff to facilitate creative, climate positive innovations in operations, project design and implementation.
Strategy I-3.2: Support equitable climate action.	
I-3.2.1	Create a report that identifies the differential impact of climate change on neighborhoods and communities.
I-3.2.2	Develop and incorporate equity metrics in the evaluation of CAAP activities. This evaluation will be used as a criterion for the CAAP Action Group, Community Climate Commission and budget team during review of program cost, viability and success.
Strategy I-3.3: Develop community leadership capacity for and involvement in climate action.	
I-3.3.1	Align existing City educational and engagement programs with CAAP goals and programs. Provide additional support to education and outreach for the CAAP and its individual actions.
I-3.3.2	Engaging with community partners, identify unmet community needs, barriers and opportunities to improve access to the green job economy for all community members.
I-3.3.3	Design and promote CAAP educational materials to ensure full engagement of community members by using methods that are accessible and relevant to all.
I-3.3.4	Develop CAAPtains to serve as ambassadors for the CAAP activities, especially youth.
Strategy I-3.4: Secure organizational and staff implementation capacity.	
I-3.4.1	Develop specific funding options for CAAP priorities.
I-3.4.2	Track cost savings associated with CAAP action across the City organization and allocate for use in supporting further mitigation and adaptation actions.
I-3.4.3	Evaluate staffing requirements to ensure successful CAAP implementation and allocate required resources.

Strategy I-3.5: Support CAAP progress through regular, transparent community reporting and education.	
I-3.5.1	Use online dashboard to report on the status of CAAP priority actions/KPIs (e.g., progress of actions that have been initiated, implementation schedule of other actions not yet started, community and municipal GHG emissions, equity impacts of actions implemented).
I-3.5.2	Host a community event every two years to celebrate the annual progress report on the implementation of the CAAP.

SECTOR-SPECIFIC STRATEGIES AND ACTIONS

The following sections detail the strategies and actions the City and community will need to take to help reach our carbon pollution reduction and climate resiliency goals. To reduce community and municipal GHG emissions, Columbia will have to accelerate the adoption of clean energy, reduce miles traveled in fossil fuel vehicles, phase in electric appliances and reduce waste. Maximizing climate resilience will require ensuring the built environment can sustain people in extreme heat, through flooding and changing ecological conditions. The City will achieve this by developing building resilience, creating climate-resilient green space, and providing community centers. This Plan's actions focus on policies, programs and infrastructure. It is expected that education and outreach actions will be developed as we implement. Some of the potential actions discussed during the Plan's development are included in the introduction for each sector.

Actions labeled "priority" are actions that should be implemented in the earlier phases of the CAAP. Priority actions will be detailed in the implementation plan (responsible party, timeframe, partnerships needed, next steps, etc.). "Other" actions will not be detailed in the implementation plan and usually rely on a priority action happening first.

The goals of the CAAP address both climate mitigation (reducing greenhouse gas emissions) and climate adaptation (improving resilience to climate impacts) and are denoted as follows:

Mi	Climate mitigation strategy (reduces greenhouse gas emissions)
Ad	Climate adaptation strategy (increases resilience to climate impacts)
Mi/Ad	Both (addresses both mitigation and adaptation goals)

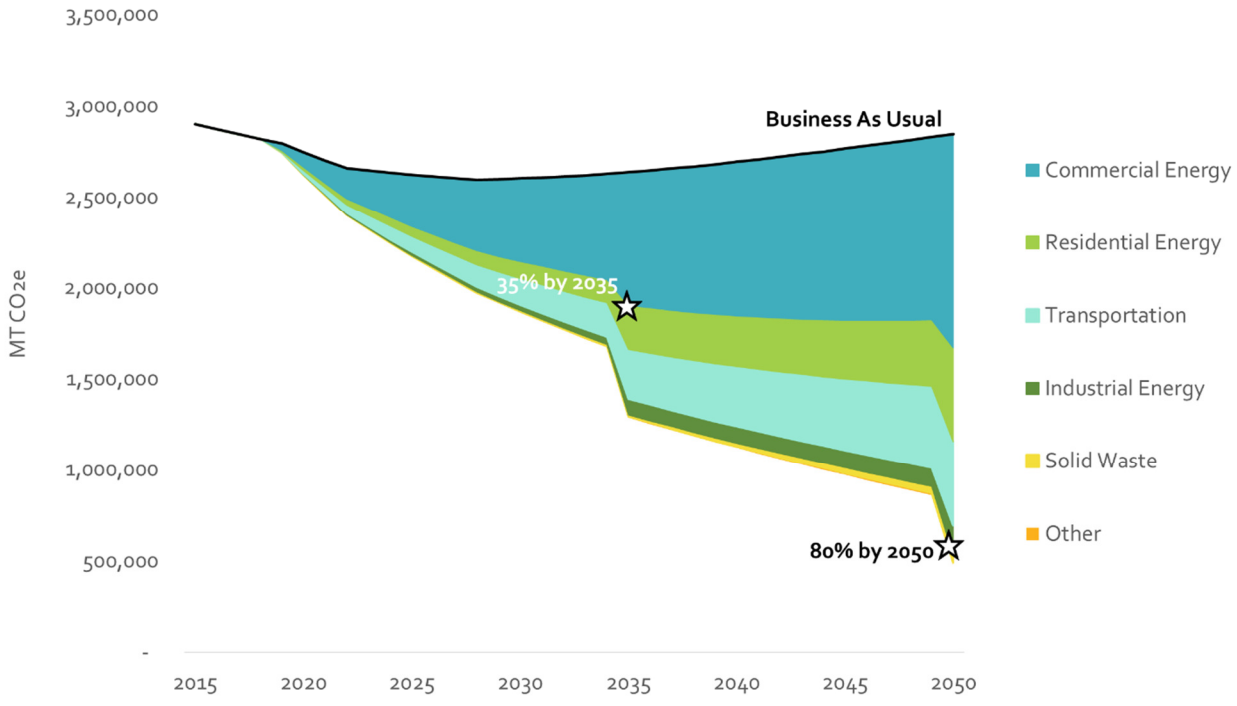
Modeling Impact: The Wedge Analysis

The wedge analysis models the potential impact of fully implementing CAAP strategies. The wedge analysis builds on Columbia's forecast and incorporates emissions savings associated with cleaner electricity, reductions in energy demand, efficient vehicles, solid waste management, and tree carbon sequestration. The wedge analysis suggests that if Columbia fully implements the strategies and actions of the CAAP, the community can meet its GHG reduction targets. **Specifically, the wedge analysis shows Columbia can achieve a 56% reduction in communitywide emissions from 2015 levels by 2035, and an 83% reduction by 2050.**

The wedge analysis:

- Is based on the City's current community GHG emissions inventory.
- Is based on best estimates of what is possible given current and anticipated technologies, policies, programs and human behavior.
- Does not take costs of actions into consideration (i.e., assumes that the City will find and commit funding to the action).
- Accounts for interactions among strategies and actions.
- Includes consideration of future climate change impacts on heating and cooling energy use.

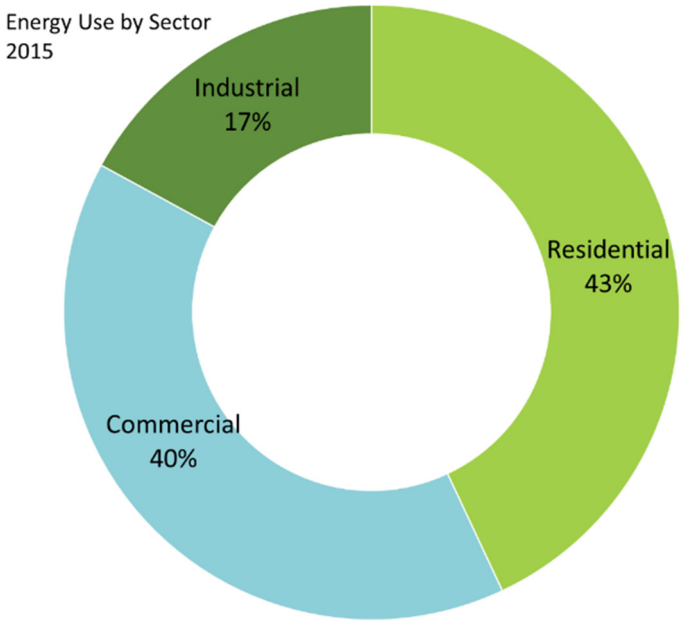
Caption: Wedge analysis of Columbia's communitywide GHG emissions, depicting potential emission reductions from identified strategies as compared to a business-as-usual scenario (by sector).



Energy

Energy refers to electricity generated and delivered to the Columbia community. Energy consumption accounts for 70% of Columbia's total GHG emissions and adopting clean energy is by far the most impactful modeled CAAP strategy. Energy-related emissions come from electricity used in homes, businesses and industry. Columbia's electricity is the primary factor in energy emissions, which means adopting clean energy has a large impact on community GHG emissions.

Climate change will impact energy use in Columbia. As air temperatures rise, the use of air conditioning may increase, leading to increased energy use, household cooling costs and GHG emissions. Households with lower annual incomes may be less likely to have air conditioning or may be more affected by increased energy costs.



Strategies and Actions

This sector includes strategies for increasing renewable energy generation, managing energy demand and increasing grid resilience. To increase renewable energy installation, the City can install solar panels on municipal buildings, streamline permitting for renewable energy, and support community solar programs. Adopting renewable energy can reduce energy costs and reduce air pollution associated with coal-produced electricity.

Columbia Water & Light can support CAAP goals by purchasing and producing renewable energy and moving towards 100% renewable electricity generation. Increasing grid resilience helps support the City's energy supply in times of natural disaster and peak energy demand. For example, distributed energy storage can help smooth out the peaks and valleys of renewable energy sources like wind and solar and improve community capacity to maintain electricity with regional outages. Additionally, behavior change can help the utility manage peak demand during the hottest parts of the summer. Reducing peak demand helps the utility and ratepayers save money and prevent outages.

Throughout this, and every sector, education and outreach will play a critcal role. City staff, the Task Force, and community members noted frequently during this process that the programs, policies and changes needed to meet the CAAP goals can only be valuable if people know they exist, why they are helpful and how to access them. Implementation strategy I-3.3: "Develop community leadership capacity for, and involvement in, climate action," prioritizes this crucial strategy to ensure education and outreach will be a part of its successful implementation.

Goal E-1. Increase local renewable energy generation and procure renewable electricity.

Strategy E-1.1: Increase on-site renewable energy installations in new and existing buildings.		
E-1.1.1	Offer community solar program through Water & Light.	Priority
E-1.1.2	Develop and implement virtual/aggregate net metering policies and procedures with Water & Light to allow privately developed community solar.	Priority
E-1.1.3	Install solar panels on all City buildings and sites, where feasible.	Priority
E-1.1.4	Streamline and offer expedited permitting for renewable energy installations.	Priority
E-1.1.5	Make it easier for large multi-family, commercial, and industrial customers to maximize the benefit of using their space for photovoltaics (e.g., feed-in tariff, third-party lease agreements, and roof space rental).	Priority
E-1.1.6	Require production meters on all new net-metered photovoltaic installations.	Priority
E-1.1.7	Determine the true value and potential of customer-owned photovoltaics to the infrastructure, economics, and renewable goals of Water & Light. Analysis should include time of generation, capacity credit, distribution circuit support, customer characteristics, technical and market potential, etc.	Priority
E-1.1.8	Require all new commercial buildings to be solar ready.	Other
E-1.1.9	Permit lease program for photovoltaic on buildings connected via net metering open to Water & Light and third party vendors.	Other
Strategy E-1.2: Maximize Columbia Water & Light's renewable energy purchasing and production.		
E-1.2.1	Include CAAP priorities in Columbia Water & Light's long range electric and water resource planning goals.	Priority
E-1.2.2	Consider all renewable energy sources on a cost per metric ton of carbon dioxide equivalent basis reduction in the City's integrated electric resource plan.	Priority
E-1.2.3	Invest in local solar fields.	Other
Strategy E-1.3: Revisit and adjust Columbia's Renewable Energy Ordinance to meet climate goals.		
E-1.3.1	Remove 3% rate cap to allow for increased investment by Water & Light in renewable energy resources.	Priority
E-1.3.2	Codify through ordinance Columbia Water & Light's responsibility to meet 100% renewable energy generation or purchase by 2035, including parameters for the use of Renewable Energy Credits (RECs) and equity and cost impacts.	Priority

Goal E-2. Maintain reliability of local energy supply and local distribution.

Strategy E-2.1: Create a resilient energy grid.		
E-2.1.1	Develop energy storage (battery) programs for all customer types to reduce peak demand, support electric grid reliability and improve the effectiveness of solar and other renewable energy options.	Priority
E-2.1.2	Ensure equitable implementation of grid resilience actions by partnering with vulnerable neighborhoods and non-governmental organizations to develop resilience hubs—community facilities that offer power and other community services during times of need. Establish criteria to screen and select locations for community microgrids to support grid and community resilience.	Priority
E-2.1.3	Maintain current rate of reliability due to weather related power outages. Investigate energy storage possibilities, such as batteries, to increase reliability.	Other
Strategy E-2.2: Manage energy demand to reduce peak energy use.		
E-2.2.1	Install meters that allow for rate structures incentivizing lower electricity use at peak hours.	Priority
E-2.2.2	Increase, enhance and implement demand side management programs.	Other
E-2.2.3	Implement utility scale energy storage.	Other

Good for all

Will our sustainable vision of Columbia support economic growth for the City and opportunities for its families?

An important part of the evaluation process for the actions in this CAAP has been their impact, positive, negative or undetermined, on factors beyond their intended effect. For example, in Columbia, where the majority of housing units are renter-occupied, an action by the City requiring rental properties meet efficiency standards has the potential to affect multiple aspects of many people's lives.

While the action is intended to reduce energy use emissions and improve tenants' ability to meet basic needs, its ultimate implementation must balance impacts to property owners' cost of doing business as well. The business impacts of policies can be balanced by incentives, financing and compliance options. The effect of energy efficiency improvements can be increased with tenant education and awareness of efficient rental options.

By design, the Task Force included representation of many parts of the community - small and large businesses, developers, insurance agencies, students, advocacy groups, etc.- with the goal to broadly consider how to achieve the benefits from CAAP actions while maintaining and improving the vitality of our Community resources. As a result, spirited discussion accompanied the evaluation of Plan actions during the development process. Wherever possible, the Task Force chose to emphasize incentives and support when actions depend on businesses, institutions or residents making investments in energy efficiency, renewable energy, process changes or elsewhere.

Small businesses are a fundamental resource providing jobs, goods and services, and resilience to our community. To arrive at the energy efficiency and renewable energy goals in the Plan, many actions either rely on, or benefit greatly from, the participation of the small business community. These same actions can provide great benefit to merchants, restaurateurs, tradespeople and service providers. For example: Pedestrian and transit oriented business districts reduce emissions and improve local air quality, while at the same time are shown to be more economically productive and require less infrastructure investment and maintenance.[11] Developing virtual net metering and community solar programs will allow groups of businesses or residents, renters and other community members to take advantage of falling renewable energy prices and economies of scale.

Throughout the planning process, a balance was sought between the need to make progress and the cost to our community members. Final design and implementation will also require attention to the positive, negative and undetermined impacts of the Plan on all of us.

[11] Bent, E. M., & Singa, K. (2009). Modal Choices and Spending Patterns of Travelers to Downtown San Francisco, California: Impacts of Congestion Pricing on Retail Trade. Transportation Research Record, 2115(1), 66–74. https://doi.org/10.3141/2115-09

Housing, Buildings & Development

Housing and buildings can be designed to maximize energy efficiency and reduce the consumption of electricity and natural gas. These emissions come from residential, commercial, and industrial buildings consuming electricity and burning natural gas. Designing buildings to maximize efficiency and upgrading appliances can reduce these emissions and save money.

Climate change will impact housing, buildings, and development as warmer temperatures increase cooling costs and heavier rains increase the risk of local flooding. Flooding could damage infrastructure and limit mobility for neighborhoods in flood-prone areas of the city. The City's current stormwater infrastructure may not be able to handle the amount of runoff that is expected in the future, as heavier rainstorms occur more often.

Strategies and Actions

Improving energy efficiency in the built environment and managing energy demand has social and economic benefits. Strategies focus on increasing energy efficiency support through incentives, requirements, and energy performance ratings. Supporting energy efficiency for low-income residents through rebates and landlord requirements will help tenants spend less money on energy and reduce GHG emissions. The Utility Services division of Columbia Water & Light has the opportunity to manage programs that incentivize efficient appliances and reduce peak demand. Additionally, building energy use disclosures can drive energy efficiency improvements. By monitoring their energy usage, commercial, industrial and residential buildings can identify opportunities for energy savings. Strategies focus on reducing energy use across all sectors through monitoring, building upgrades, and behavior change.

These programs will require the development and implementation of training programs for professionals (e.g. contractors, designers, landlords, realtors, etc.) in the built environment. Education and outreach will help show the impact of the built environment on a larger scale. Educational opportunities for residents will also be provided, so that smart, sustainable choices can begin at home.

Columbia will work towards achieving zero-emissions buildings and increasing climate resilience. The City can develop policies and incentives that phase in electric appliances as the City adopts clean energy. Supporting development of buildings that can withstand projected weather changes through code updates will help new buildings be resilient to climate changes.

Goal H-1. Reduce housing-, building-, and development-related energy consumption and improve resiliency.

Strategy H-1.1: Increase energy efficiency in residential buildings.		
H-1.1.1	Promote and offer incentives for improving residential energy efficiency during retrofit projects that exceed existing building energy code requirements. For example, using higher performance insulation materials in order to meet new construction energy code standards.	Priority
H-1.1.2	Increase energy efficiency funding options for families (low-interest financing, on-bill financing, Pay As You Save, PACE, etc.).	Priority
H-1.1.3	Establish a date by which all rental housing will be required to meet basic energy efficiency standards at license renewal.	Priority
H-1.1.4	Develop and test an energy performance rating/labelling program for homes listed for sale or upon rental license renewal.	Priority
H-1.1.5	Phase in NetZero or highly energy efficient building requirements into the building code.	Other
H-1.1.6	Develop standard deep retrofit specifications and incentives for existing residential building owners to reduce the carbon footprint of the building to zero.	Other
H-1.1.7	Promote and offer incentives for improving residential energy efficiency in new construction (e.g., insulation, energy-efficient windows, electric heat pumps). New construction incentives shall support measures for projects that exceed code requirements.	Other
H-1.1.8	Formalize a Community Cost Share Fund for tax advantaged donations to go towards energy efficiency education and improvements for renters. Track with event attendance and participation in rental efficiency improvements.	Other
Strategy H-1.2: Increase energy efficiency in commercial buildings.		
H-1.2.1	Provide assistance to commercial buildings above a minimum gross floor area to track energy and water usage. Require all such commercial buildings to disclose their energy and water use.	Priority
H-1.2.2	Develop specific energy efficiency programs for hard-to-reach segments of commercial properties (e.g., commercial rental, restaurants, large scale manufacturing, offices, affordable multi-family housing).	Priority
H-1.2.3	Promote and offer incentives for improving energy efficiency (e.g., insulation, energy-efficient windows, electric heat pumps) in newly constructed commercial properties. New construction incentives shall support measures for projects that exceed code requirements.	Priority

H-1.2.4	Identify funding strategies to ensure rebate budgets are sufficient to meet expanded offers and goals.	Priority
H-1.2.5	Create Water & Light Utility Services rebate programs that provide incentives based on energy use reduction in addition to demand reduction (e.g., lighting controls, outdoor lighting, energy recovery ventilation, carbon dioxide controls, custom rebate).	Other
H-1.2.6	Require newly constructed buildings larger than 15,000 square feet to meet LEED Gold, Enterprise Green Communities, the 24 National Green Building Standard ICC/ASHRAE 700, or an equivalent certification.	Other
H-1.2.7	Require existing buildings larger than 15,000 square feet and exceeding minimum alteration thresholds to meet building certification of LEED Silver, Enterprise Green Communities, the 27 National Green Building Standard ICC/ASHRAE 700, or an equivalent certification.	Other
H-1.2.8	Develop deep retrofit standard requirements and incentives for owners of existing commercial buildings less than 15,000 square feet to reduce the carbon footprint of the building to zero.	Other
Strategy H-1.3: Increase energy efficiency in municipal and school buildings.		
H-1.3.1	Create a policy that all City buildings shall reduce energy usage by 20% over the next five years.	Priority
H-1.3.2	Create a policy, to be part of assigned duties and presented during new employee orientation, that City employees shall turn off lights and equipment when they are done using them.	Priority
H-1.3.3	Introduce a policy that requires all new and existing municipal buildings to meet and maintain energy and resource efficiency standards (ENERGY STAR, LEED, Home Energy Score or other).	Priority
H-1.3.4	Introduce a policy that requires all municipal buildings to be benchmarked with the current Energy Score rating, the energy use intensity (kBTU/sqft) and the energy reduction goal. These benchmarks and goals shall also be posted on the City's website.	Priority
H-1.3.5	Create a target of net zero energy use at all municipal buildings by 2025.	Other
H-1.3.6	Work with school districts to support energy efficiency programs, geothermal energy and solar energy installation.	Other
Strategy H-1.4: Decrease the impact of building stock on local air pollution and greenhouse gas emissions.		
H-1.4.1	Require that the City adopts the International Building Energy Conservation Codes for municipal, commercial and residential buildings as written.	Priority

H-1.4.2	Improve training, certification and education opportunities for professionals involved in the disposal and use of refrigerants.	Other
H-1.4.3	Require, when cost comparable, that new air conditioning units use refrigerants with low global warming potentials (e.g., carbon dioxide or ammonia instead of hydrofluorocarbons).	Other
H-1.4.4	Develop incentive programs to transition lawn care companies and homeowners from using fuel-burning lawn equipment (e.g., lawn mowers, blowers) to electric.	Other
Strategy H-1.5: Decrease use of fossil fuels in housing and other buildings.		
H-1.5.1	Incentivize switching space and water heating from fossil fuel-based to electric heat pumps.	Priority
H-1.5.2	Invest in district heating and cooling for downtown City and County buildings.	Other
Strategy H-1.6: Support development of buildings that are resilient to anticipated future conditions.		
H-1.6.1	Require light colored roofs and/or a minimum specified reflectance for commercial roofs when new or at replacement.	Other
H-1.6.2	Develop affordable and efficient (temporary/transitional) housing options.	Other
H-1.6.3	Introduce a policy that limits new construction in the 500-year flood zone and/or requires infrastructure to be elevated two feet above anticipated flood level (no infrastructure equipment in lowest level).	Other

Transportation

Transportation refers to the form and function of transportation systems, including private vehicles, public transportation, and walking and biking infrastructure. Transportation made up 27% of Columbia's GHG inventory in 2015. Local, on-road transportation of passengers in privately-owned vehicles account for the majority of these emissions in Columbia.

Climate change may lead to more intense rain events and flooding, affecting road conditions in Columbia. Floods could temporarily block roadways and trails. Warmer temperatures and extreme heat may weaken pavement and require more maintenance. On the other hand, warmer winters may mean fewer instances of freezing and thawing and therefore less demand for other types of maintenance. Columbia residents who rely on walking or biking may be more exposed to extreme heat and poor air quality.

Expanding public transit and building bicycle and pedestrian infrastructure will help reduce GHG emissions by reducing reliance on personal vehicles for transportation. This includes funding public transit expansion and prioritizing walking and biking infrastructure. Implementing the City's Vision Zero plan will be important for success.

Building sidewalks, bike lanes, crosswalks and other infrastructure can fill-in connectivity gaps identified in City plans. Additionally, creating walkable communities through mixed-use development and infill can connect neighborhoods to schools, community centers and local businesses. This will help reduce the distance people need to travel to meet basic needs.

When people do need to travel in vehicles, Columbia can help encourage low emissions vehicles. Within the City's own operations, GoCOMO, Columbia's transit system, uses nine electric buses. City fleets can add electric and hybrid vehicles and the City can encourage private adoption of zero-emission vehicles by increasing the number of electric charging stations in public parking areas.

All transportation strategies and actions require the City to increase advocacy for the use of multi-modal transportation in Columbia. Efforts to change the public perception of non-personal vehicle transportation is necessary to achieve success in reducing transportation emissions.

Many actions below focus on adjusting the share of different modes of transportation to reduce transportation related emissions. The following mode shares provide a path for us to meet our transportation emission reduction targets:

	Baseline*	**2035**	**2050**
Single Occupancy Vehicle	78%	40%	10%
Carpool	9%	20%	5%
Transit	1%	15%	40%
Walking	5%	10%	25%
Biking	1%	5%	20%

* From 2012-2016 ACS values do not total to 100% due to some ineligible responses.

Goal T-1. Reduce travel by car.

Strategy T-1.1: Prioritize safety and convenience of walking, biking, and riding transit.		
T-1.1.1	Prioritize transportation funding for Vision Zero engineering improvement projects to create safe streets for people walking, biking and riding transit.	Priority
T-1.1.2	Revise street design standards to prioritize people walking, biking and riding transit while also accommodating vehicles.	Priority
T-1.1.3	Prioritize transportation funding to achieve mode share goals.	Priority
Strategy T-1.2: Build a thriving public transit system.		
T-1.2.1	Improve efficiency, convenience and reliability of bus service and infrastructure (e.g., increase frequency, shorten wait times, construct bus stop shelters).	Priority
Strategy T-1.3: Create a bikeable community.		
T-1.3.1	Build and maintain a network of on-street protected bike lanes on streets with speed limits above 30 mph. Build other bike facilities (e.g. bike boulevards, etc.) on streets with lower traffic/speed.	Priority
T-1.3.2	Establish a bike share program.	Other
Strategy T-1.4: Create a walkable community.		
T-1.4.1	Accelerate building sidewalks, crosswalks, and other walking infrastructure in high-need areas and fill connectivity gaps as identified in Sidewalk Master Plan.	Priority
T-1.4.2	Install universal design accessibility features at crossing locations to ensure the crossing is accessible for everyone (e.g., pedestrian traffic signals, audible signals).	Priority
Strategy T-1.5: Shift land use patterns to shorten trips and reduce the need to drive.		
T-1.5.1	Revise zoning codes to favor walkable, connected neighborhoods in the existing built environment, near schools and new development.	Priority
T-1.5.2	Incentivize infill and mixed-use development (e.g., through alternative code compliance, fee waivers, density bonuses, investment prioritization, development impact fees, tax benefits).	Priority
T-1.5.3	Revise zoning codes to encourage Accessory Dwelling Units (i.e., mother-in-law units).	Priority

T-1.5.4	Preserve and enhance affordable housing, especially near bus service, to prevent displacement of vulnerable populations.	Priority
T-1.5.5	Partner with Columbia Public Schools to adjust school siting requirements to prioritize building schools in walkable and bikeable areas.	Other
T-1.5.6	Eliminate parking minimums and reduce surface parking.	Other

Goal T-2. Reduce greenhouse gas emissions from vehicles.

Strategy T-2.1: Encourage use of low- to zero-emission vehicles.		
T-2.1.1	Introduce a policy to replace City fleet vehicles and buses with electric and hybrid options at the time of replacement, and require emissions standards, testing and biofuel preference for any combustion vehicles remaining in the fleet.	Priority
T-2.1.2	Create an EV roadmap to increase number of electric charging stations in public parking areas (e.g., schools, parks, libraries, city-owned parking garages, near city hall) and in commercial and high-density residential areas.	Priority
T-2.1.3	Encourage installation of EV charging capacity in single family and multifamily residences (e.g., how to address residences that lack garage access).	Priority
T-2.1.4	Incentivize the purchase of electric vehicles through rebates on vehicles and/or residential chargers.	Other
Strategy T-2.2: Reduce use and ownership of personal vehicles.		
T-2.2.1	Solicit a car share program, such as Zipcar or Get Around, to provide cars in a central location.	Other
T-2.2.2	Identify locations and partners to facilitate carpooling, telecommuting options, and parking buyback programs for municipal and other employers in the region.	Other
Strategy T-2.3: Improve efficiency of vehicle traffic.		
T-2.3.1	Implement street design to improve road and vehicle efficiency (e.g., roundabouts, synchronize traffic signals, road diets).	Other

Density and Community Character

Growth and development have been hot topics for Columbia residents for decades. Recent high-rise student housing developments in the downtown area, multifamily developments in predominantly single home neighborhoods and mixed-use development in residential areas have all elicited diverse community opinions. When done thoughtfully, mixed-use and higher-density development play a critical role to reduce for emissions and build resilience. It is also important to address concerns of increased traffic, reduced parking and changes to neighborhood character.

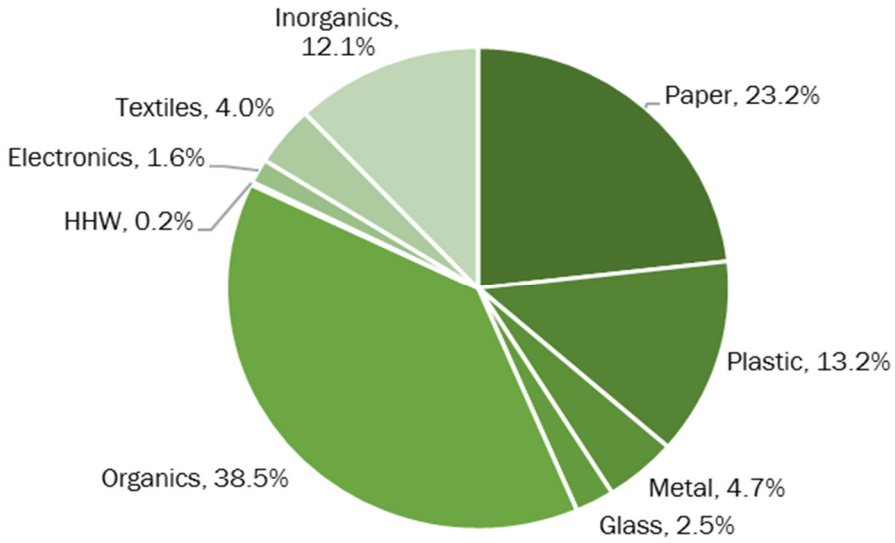
Mixed-use and higher-density development helps shorten travel times, increase usage of transit and reduces the need to own a car. Denser development is more energy efficient and reduces the costs of providing public services. These benefits help reduce greenhouse emissions and create stronger and more resilient neighborhoods. Recent apartment construction downtown and mixed-use developments throughout the City demonstrate a demand for this type of beneficial development. This philosophy is also reflected in City's 2013 Comprehensive Plan, “Columbia Imagined - the Plan for How We Live & Grow” and in provisions in the 2016 Unified Development Code, which support dense/walkable neighborhoods, infill development and a compact urban boundary. To successfully navigate this or any new approach requires an openness to change by businesses, government and residents.

Tensions around these projects have created controversy and taken over community conversations. They have even drawn criticism from supporters of more sustainable development. Reduced parking availability, increases in vehicular and foot traffic and changes to a neighborhood’s visual characteristic are concerns. They are also concerns we can address as a community for future developments. Columbia is growing and accommodating that growth with sustainable development is vital for meeting our GHG emission reduction goals. Continuing the community conversation around sustainable development will support our progress in meeting the goals in this Plan.

Waste

When waste goes to landfills, it breaks down and generates greenhouse gases. GHG emissions from the disposal of solid waste contributed 2% to Columbia's 2015 inventory. There are opportunities to reduce emissions associated with various parts of the lifecycle of goods and services, including manufacturing, use and disposal. Overall, reducing consumption is the most effective way to reduce waste. For waste that is generated, diverting materials to recycling or compost can reduce remaining emissions.

Caption: The majority of waste generated by Columbia residents and businesses could be composted or recycled, as indicated by findings from the last statewide waste composition study (Source: MDNR 2016-2017 Statewide Waste Composition Study; data for Columbia Landfill; "inorganics" largely includes construction and demolition waste).



Strategies and Actions

Waste reduction strategies involve both behavior change and access to recycling and composting. Understanding the waste stream is essential to identifying opportunities to divert waste from the landfill, so strategies include regular waste characterization. To incentivize waste diversion, strategies focus on requiring all homes have access to recycling, proper construction and demolition waste management and rate structuring to encourage recycling.

Reducing emissions associated with consumption and lifecycle management of products include appropriately disposing of appliances using hydrofluorocarbons, reusing and repairing damaged appliances and salvaging usable materials from demolition.

Promotional and instructional materials on how to reduce waste, reuse materials, and recycle goods will be required to successfully implement the CAAP.

Goal W-1. Reduce waste generation.

Strategy W-1.1: Encourage reuse.		
W-1.1.1	Create a reuse program for curbside collection and purchase a warehouse to store and sell items that are not accepted by local non-profit groups.	Priority
W-1.1.2	Partner with Restore/Habitat for Humanity for demolition waste pickup and reuse.	Priority

Goal W-2. Increase diversion.

Strategy W-2.1: Reduce landfill waste through customer education, rate structures, and increasing City recycling programs.		
W-2.1.1	Restructure all solid waste rates to reduce the amount of waste sent to the landfill.	Priority
W-2.1.2	Require multifamily homes to offer on-site recycling for residents.	Priority
Strategy W-2.2: Expand composting participation and operation.		
W-2.2.1	Study the short and long term cost/benefit of a City composting program.	Priority
W-2.2.2	Offer five days a week (Monday through Friday) collection for food waste and certified compostable material at businesses. Change the type of compost operation or increase land allocation to handle additional feedstock, as needed.	Other
W-2.2.3	Offer curbside compost collection to all residential properties (i.e. single-family and multifamily) for yard waste, food waste, and certified compostable products. This service is optional for all residential properties.	Other
Strategy W-2.3: Divert construction and demolition (C&D) waste.		
W-2.3.1	Research management practices of construction and demolition waste diverted from the landfill.	Priority
W-2.3.2	Promote a C&D recycling industry in Columbia by preparing ordinance and construction permit changes that would be implemented if a C&D recycling company wishes to operate in the Columbia area. City staff will actively seek C&D recycling companies that might be interested in the Columbia area following the proposed policy changes.	Other
Strategy W-2.4: Require and incentivize recycling.		
W-2.4.1	Offer positive reinforcement and indirect financial incentives to encourage businesses and residents to divert material from the landfill.	Priority
W-2.4.2	Develop and enforce ordinances requiring commercial customers to recycle material streams like cardboard, paper, beverage containers, etc.	Priority
W-2.4.3	Offer quarterly curbside bulky-items pickup for residents and businesses.	Other

Goal W-3. Improve waste system management.

Strategy W-3.1: Encourage proper disposal of products containing high Global Warming Potential (GWP) gases.		
W-3.1.1	Research and add best practices for recycling hydrofluorocarbons (potent GHG used in refrigeration and air conditioning) in next CAAP update.	Priority
Strategy W-3.2: Upgrade solid waste facilities.		
W-3.2.1	Remodel and upgrade the City's Material Recovery Facility to increase processing capacity, add sortation technology and provide space for additional material types to be recycled, including (but not limited to) e-waste, mattresses, cartons and household hazardous wastes.	Priority
W-3.2.2	Research new technologies for enhanced landfill methane capture.	Other
Strategy W-3.3: Track waste diversion.		
W-3.3.1	Conduct a comprehensive waste composition study every five years.	Priority

Upstream emissions are important, but hard to track

The greenhouse gas emissions documented in this Plan do not represent an important category of emissions produced by our community. These are the upstream emissions associated with the production of food, material goods, and services and are exceptionally difficult to measure. These are considered consumer-based emissions, which rely on individual preferences and external sustainability initiatives. We cannot predict how the crops are grown or the type of materials used in clothing or furniture. We also cannot predict how the resources are extracted, processed and transported to our community. Global economic trade also limits our ability to reduce upstream GHG emissions, as products are often imported using the most cost-effective method, regardless of the environmental costs. Furthermore, residents can be limited by financial constraints or, more broadly, social inequality.

Some actions in the Plan encourage the lifestyle changes that are necessary to reduce consumer-based emissions. However, our ability to collect benchmarking data and document progress is very limited. Currently, we are not including this information in our community or municipal GHG emissions. As clearer methodologies are available, we will incorporate them into Plan updates. All of us can continue to work toward a more sustainable lifestyle by considering upstream emissions in our choices. We can shop local, repair and reuse materials, and make a conscious effort to purchase recyclable or compostable products.

Health, Safety and Well-being

Health, safety and well-being includes addressing impacts of climate change, such as heat stress, air quality, allergens, food security, vector-borne disease and mental health. Climate change can disproportionately impact communities that are already at risk of harm, such as low-income families, communities of color, the elderly and children, and homeless populations. For example, extreme heat can endanger people without shelter or air conditioning. The City can prepare for climate impacts by investing in community resources and public health.

Strategies and Actions

To reduce negative climate impacts, strategies focus on addressing local air quality, food security, energy costs and community resources. Many mitigation strategies have adaptation benefits. For example, warmer temperatures increase ground-level ozone, but efforts to minimize fossil fuel vehicle use can improve local air quality. Waste management strategies can also work synergistically with adaptation. As the climate changes, food production, and therefore food sales, may become more expensive. Preventing food waste through food donation can support multiple climate goals.

Preparing for extreme weather events can involve improving civic engagement and community resources. The City can promote neighborhood-led action, including preparedness training, public involvement in disaster planning and creation of community resilience centers.

Goal HS-1. Prepare the community, public safety and health services for anticipated climate change impacts.

Strategy HS-1.1: Include vulnerability assessments in planning efforts and enhance communication tools and strategies to prepare the community for anticipated climate change impacts.		
HS-1.1.1	Develop and implement a plan to monitor climate change related illnesses. Utilize results in resource and policy planning, with particular focus on neighborhoods. Communicate results to the public on a periodic basis.	Priority
HS-1.1.2	Coordinate with community health improvement teams to incorporate climate change and CAAP goals into the Community Health Improvement Plan and Health Impact Assessment.	Priority
HS-1.1.3	Review and effectively communicate emergency and evacuation plans on a regular basis to update for climate change forecasted data, paying particular attention to flooding, extended heat waves and tornadoes.	Priority
HS-1.1.4	Build City staff capacity to support community-led, neighborhood-focused resilience actions (e.g., identifying best practices, establishing resilience hubs and implementing neighbor-based emergency response).	Priority
HS-1.1.5	Partner with outside agencies to offer community resilience model training.	Priority
HS-1.1.6	Conduct a needs assessment of accessible community centers for during extreme weather or other emergency situations. Create a development improvement plan, if needed.	Other
HS-1.1.7	Deploy point-in-time alert systems (e.g., RAVE, Nixle) to notify people of extreme weather events, periods of dangerous cold, and heat waves and refer them to resources on symptoms and prevention of climate-related illness.	Other
HS-1.1.8	Develop a long-term plan for potential growth in foreign and domestic refugees.	Other
HS-1.1.9	In planning for additional fire stations and resources, incorporate projections for increased grass, brush, and backyard fires.	Other
Strategy HS-1.2: Reduce incidences of heat-related illness and death.		
HS-1.2.1	Identify a sustainable funding source for increased utility assistance for low-income residents, including support for energy efficiency projects, such as weatherization.	Priority
HS-1.2.2	Increase availability to cooling mechanisms in low-income housing and rental units (e.g., air conditioning units, fans, window screens).	Other
HS-1.2.3	Develop a plan to improve bus stop shelters' ability to provide relief from extreme heat (reflective materials, cooling fans.)	Other

HS-1.2.4	Monitor the number of utility disconnects during heat waves and assess if current policy should be updated for changing community needs.	Other
Strategy HS-1.3: Prevent and prepare for increased incidence of vector-borne diseases and illness or injury due to air and water quality issues.		
HS-1.3.1	Create anti-idling policies and enforcement plans.	Priority
HS-1.3.2	Update property maintenance code to manage and mitigate mold or fungus.	Priority
HS-1.3.3	Establish funding for a program to trap mosquitoes and ticks to monitor for disease or disease-carrying species.	Other
HS-1.3.4	Expand outdoor treatment to mitigate the spread of vector-borne diseases when evidence of local disease is identified.	Other
HS-1.3.5	Identify sources of ozone pollution in Boone County and establish a county-wide system to gather data and set thresholds to trigger actions.	Other
HS-1.3.6	Conduct a health impact assessment for areas that may have unsafe levels of air pollution from vehicle traffic, and use data to modify zoning.	Other

Strategy HS-1.4: Plan for a potential increase in demand for mental health care.		
HS-1.4.1	Form a team to develop action plans to address climate-related mental health resilience at the individual, neighborhood and community level.	Priority
HS-1.4.2	Ensure the community has robust resources to address increases in violence and crime, particularly domestic violence, during periods of stress including emergencies and heat waves.	Other

Goal HS-2. Reduce emissions associated with the food system.

Strategy HS-2.1: Increase production of local food.		
HS-2.1.1	Support organizations and schools promoting local food production and community gardens, through partnerships, funding, and educational programs on the benefits of a plant-based diet.	Priority
HS-2.1.2	Review ordinances and development regulations to promote urban farming.	Other
HS-2.1.3	Work with Regional Economic Development, Inc (REDI) to develop an entrepreneurship program for commercial urban farming.	Other
HS-2.1.4	Update code to provide incentives or require developers to preserve topsoil and provide space for backyard or community gardens.	Other
Strategy HS-2.2: Assure food security, particularly among the most vulnerable populations.		
HS-2.2.1	Continue to provide enrollment assistance for participation in the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) Program and other food assistance programs.	Priority

Are affordable housing and land preservation in conflict?

Land conservation protects and maintains the integrity of the land. Traditionally, areas outside of city limits containing large parcels of forest and grassland were preserved. With population growth, our city limits have expanded into surrounding rural areas, fragmenting the landscape, disrupting ecological processes and displacing the wildlife that support a healthy ecosystem. In addition to lowering the impact of expansion on natural resources, it is important for us to protect and conserve existing green space within city limits.

Affordable housing addresses the gap between wages and housing costs. Affordable housing is generally built where residents may access public transportation, grocery stores and other city amenities. When this development occurs on existing urban open space this could be seen as a conflict between affordable housing and urban land conservation. However, when we recognize our broader needs as a community to ensure that one does not displace the other, we can create a synergy between them that improves each one such as creating shared space that contains housing and green space that residents may use for recreation.

People benefit from open space as it provides trees for shade, clean air and water, mitigation of stormwater runoff and many other ecosystem services. Conservation-based affordable housing can be designed and built to provide both housing and open space that serves the community. The Lynn Street Cottages development is a good example of this type of development. The project included the development of eight affordable owner-occupied homes with near net-zero energy usage design and universal design features. The homes were developed in a cottage housing style arrangement to increase the density of the development. The development also included significant stormwater improvements to benefit the surrounding neighborhood.

Columbia's master plan for community development outlines how neighborhoods may be designed to protect intact habitats while still providing housing by building homes closer together. This design allows natural areas to remain intact and creates an attractive neighborhood feature for residents. Additionally, in more urbanized areas where there is less land available for new development, neighborhood (parks and community gardens) and residential landscaping that uses native plants can help bridge the gap between infrastructure development and ecosystem conservation.

Sustainable communities provide jobs with living wages, affordable housing, and the ecosystem services necessary for life. Using management practices to create new partnerships and explore innovative ideas for developments that embody both land conservation and affordable housing will help meet Columbia's need for sustainable land conservation and housing.

Natural Resources

Natural resources refers to street trees, natural areas, and biodiversity conservation as well as water quality and supply. Climate change may increase heavy precipitation, lead to extreme heat, and shift the life cycle timing of our natural ecosystems. Maintaining and enhancing natural resources can increase natural resilience to climate impacts.

Strategies include supporting urban forests and greenspace. Urban forests and tree management can help cool homes and businesses during extreme heat events. Greenspace supports wildlife, stormwater management, and recreation. Strategies focus on protecting and managing open space as climate change alters ecosystems. Conserving water is also a key way to protect natural resources. The City can update building codes, focus on incentivizing water conserving appliances, and manage roadside vegetation to increase stormwater absorption.

Actions that protect and conserve biodiversity will create a more resilient Columbia. These actions will be supported by educating the community about the benefits of nature in our city and how to incorporate it into their everyday lives through sustainable landscaping, design, and stewardship.

Goal NR-1. Increase climate resilience and carbon sequestration potential of public and private lands.

Strategy NR-1.1: Increase the accessibility and quality of habitat for native plants and animals.		
NR-1.1.1	Manage publicly-owned natural areas to enhance and maintain diverse native communities.	Priority
NR-1.1.2	Establish and effectively manage native habitat corridors along trails and utility easement areas to restore and maintain landscape connectivity.	Priority
NR-1.1.3	Create an ordinance that establishes a Transfer of Development Rights program to protect undeveloped lands for land conservation and/or agriculture.	Priority
NR-1.1.4	Support the Urban Forest Master Plan to identify programs and suitable locations to maintain and expand Columbia's urban tree canopy.	Priority
NR-1.1.5	Update current tree preservation requirements to protect tree root systems and large legacy trees during construction.	Priority
NR-1.1.6	Assess whether or not to purchase and preserve greenspace in and surrounding the city by quantifying the equitable, environmental, and economic benefits along with the costs of maintaining and owning the property.	Other
NR-1.1.7	Require the use of climate-adapted plants in landscaping at City-owned properties.	Other
NR-1.1.8	Update current development regulations to recommend or require the use of appropriate climate-adapted trees and plants for new- and re- development.	Other
NR-1.1.9	Identify underutilized paved areas and incentivize conversion to sustainable green space.	Other

Goal NR-2. Reduce per capita water usage.

Strategy NR-2.1: Encourage water conservation.		
NR-2.1.1	Complete change to rate structure to encourage reduced water use.	Priority
NR-2.1.2	Update building code to require water conservation measures (e.g., grey water infrastructure, drought resistant landscaping) in new construction and renovations.	Other
NR-2.1.3	Develop a technical assistance and incentive program to encourage water conservation behavior and upgrades, such as use of drip irrigation and low-flow toilets.	Other

Goal NR-3. Reduce negative impacts from stormwater runoff and flooding.

Strategy NR-3.1: Improve stormwater management.		
NR-3.1.1	Implement strategies to mitigate stormwater impacts due to development and redevelopment of properties currently exempted from stormwater management requirements.	Priority
NR-3.1.2	Build more permeable parking lots and driveways and use more recycled materials with concrete.	Other
Strategy NR-3.2: Minimize risks to flood-prone areas.		
NR-3.2.1	Mine existing data sources (e.g., FEMA Risk Maps) to identify areas prone to flooding.	Priority
NR-3.2.2	Perform detailed studies to identify areas that are at high risk for flooding and may be prospect for property acquisition or mitigation.	Priority
NR-3.2.3	Increase stream buffer requirements to provide additional flood water storage and minimize property damage due to erosion and flooding.	Priority
NR-3.2.4	Perform a flood risk assessment using historical data and future precipitation forecasts to identify areas and critical infrastructure vulnerable to flooding.	Priority

Checklist for reducing your own carbon footprint

REDUCE MY IMPACT FROM CONSUMPTION

- ☐ Reduce the amount of food my household wastes.
- ☐ Compost organic waste in my backyard.
- ☐ Fix things that are broken instead of buying new.
- ☐ Use the Household Hazardous Waste and bulky item pick-up programs to properly dispose of old refrigerators, e-waste, air-conditioning units, and household chemicals.
- ☐ Learn how and where to recycle items.
- ☐ Talk with my contractor about alternatives to traditional building demolition, such as relocation, deconstruction, and salvage.
- ☐ Shop locally and support local businesses, especially those that demonstrate climate positive actions.
- ☐ Support the recycling industry by purchasing items that contain recycled material (e.g. office paper with 40% post-consumer content).
- ☐ Support efforts to reduce and limit single-use disposable plastics.
- ☐ Replace high-carbon foods with minimally processed foods, fruits, grains, and vegetables.
- ☐ Encourage the creation of community gardens on public and private lands including school campuses, City lands, and church properties.
- ☐ Start a tool lending library in my community.

REDUCE MY ENERGY USE

- ☐ Get an energy audit to find ways to increase energy efficiency at home and at work.
- ☐ Install energy conserving appliances and fixtures, such as on-demand tankless water heaters, Energy Star appliances, and LED lightbulbs.
- ☐ Install electric heat pumps, water heaters, dryers, stoves, and more.
- ☐ Install a programmable thermostat and remember to set it back when I am gone.
- ☐ Talk to my neighbors, co-workers and City Council members about policies that reduce our greenhouse gas emissions.
- ☐ Use fans or warm clothing to reduce energy I use for air conditioning or heating.
- ☐ Strategically place trees in my yard to shade my house and reducing my need for air-conditioning in the summer.
- ☐ Consider efficient alternatives to traditional water heaters, like tankless water heaters, electric heat pump water heaters, or solar thermal hot water heaters.
- ☐ Set a goal of reducing my household's hot water use by 15%.

CONSERVE WATER

- ☐ Conduct a water audit at my home, and replace inefficient toilets, shower heads, and other fixtures.
- ☐ Install a rain barrel to harvest rainwater for outdoor use.
- ☐ Fix leaks in toilets and faucets promptly.
- ☐ Replace turf grass with drought-tolerant landscaping or native plants.
- ☐ Install smart technology on existing irrigation systems.
- ☐ Wash full loads of dishes and laundry.

PROTECTING OUR LOCAL WATERWAYS

- ☐ Don't be a litterbug. Items thrown on the ground are likely to end up in the nearest water source, making clean up even more difficult. Make sure your trash is contained and that any recyclables are properly discarded.
- ☐ If you choose to smoke please dispose of your cigarette butts properly.
- ☐ Picking up after your dog helps reduce the likelihood of its fecal bacteria ending up in an increasingly contaminating local recreational waterways.
- ☐ Fertilizers contain chemicals that are good for lawns and plants when used properly, excessive amounts applied to lawns and gardens wash off and pollute local streams and recreational waterways.

EMBRACE NON-CAR TRAVEL

- ☐ Set a goal to increase the number of trips I make by transit, carpooling, walking, or biking.
- ☐ Organize a "walking school-bus" to walk a group of kids to school.
- ☐ Delay my next purchase of a new vehicle, if it's possible to get more life out of my current car.
- ☐ When I decide to make a purchase, I'll investigate electric vehicles and hybrids.
- ☐ Use alternatives to air travel when possible.
- ☐ Support development that creates vibrant, higher density, mixed-use areas to reduce the need for driving.

OVERVIEW:

COLUMBIA'S VULNERABILITY TO CLIMATE CHANGE IMPACTS

Background

As part of its Climate Action and Adaptation Planning process, the City of Columbia undertook a comprehensive effort to better understand local vulnerabilities and risks associated with projected changes in climate. A consultant team reviewed the best scientific information available about changes in temperature, precipitation, and other climate-related factors that Columbia may experience; those findings are available in the climate trends summary. That information was then applied to Columbia's unique social, economic, and environmental context with inputs from City staff and the Mayor's Task Force. The consultant team proposed vulnerability rankings based on this analysis, taking into account three key factors in relation to anticipated climate change impacts:

1. **Exposure:** the number of people and value of assets in harm's way or at risk due to their physical location.
2. **Sensitivity:** the severity of consequences of being exposed to these risks and the degree to which climate change exacerbated existing stressors.
3. **Adaptive capacity:** steps the City and community are already taking to prepare for climate change impacts and whether they have existing capacity to accelerate and/or expand those efforts, if needed.

The Climate Action Task Force reviewed and made adjustments to some of the vulnerability rankings based on their understanding of local issues and the projected changes in climate. This overview summarizes the findings of the vulnerability assessment. More detailed information about each focus area is provided in a series of four supplementary factsheets.

How is Columbia vulnerable?

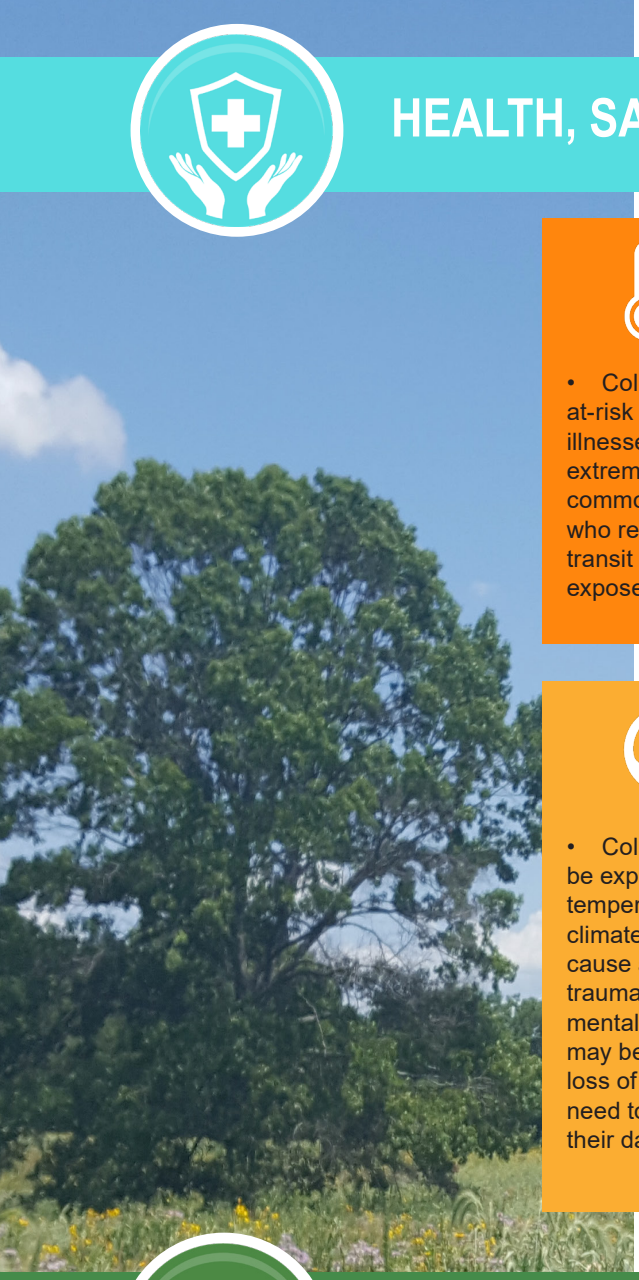
The table lists the categories by their relative vulnerability to climate change impacts. The subsequent sections provide more detailed descriptions of the vulnerability of each focus area.

Relative Vulnerability

HIGH	Heat stress, Air quality, Vector-borne diseases
MEDIUM-HIGH	Housing, Mental health
MEDIUM	Agriculture, Stormwater management
LOW-MEDIUM	Transportation, Surface water quality, Drinking water supply, Trees and open space
LOW	Solid waste, Energy, Drinking water quality

Equity and Climate Change

Some Columbia residents may be more vulnerable to climate change impacts. Low-income households may have fewer options to respond to and prepare for all types of impacts, such as paying higher energy bills for more air conditioning or repairing property damages after a flood event. Health-related impacts may disproportionately affect children, older adults, pregnant women, outdoor workers, and individuals with pre-existing illnesses or weak social ties. People with limited mobility or who rely on walking, biking, and public transportation may experience more difficulty in getting around during times of extreme heat or other severe weather.



HEALTH, SAFETY, AND WELL-BEING

Heat stress

- Columbia residents may be more at-risk of heat stress and heat-related illnesses as temperatures warm and extreme heat events become more common. Outdoor workers and people who rely on walking, biking, or public transit to get around may be more exposed to these impacts.

Vector-borne diseases

- Columbia currently has a low incidence of common vector-borne diseases, but increasing temperatures may support population growth of mosquitoes, ticks, and other vectors.

Mental health

- Columbia residents may be exposed to more extreme temperatures, severe weather, and climate-related disasters, which could cause anxiety, depression, post-traumatic stress disorder, and other mental health consequences. People may be more at risk if they experience loss of life, resources, or property, or need to make significant changes to their daily routine.

Air quality

- Warmer temperatures in Columbia may lengthen the pollen season and cause more ozone smog pollution, which lowers outdoor as well as indoor air quality. Heavy rain events and higher humidity may also create favorable conditions for mold, dust, and other indoor air contaminants.
- These negative impacts on air quality may worsen asthma, allergies, and other respiratory health conditions.

OPEN SPACE AND AGRICULTURE

Trees and open space

- Warmer temperatures and increasing drought will likely stress trees and shrubs in Columbia, making it more difficult for new plantings to survive and increasing the risk of disease, pests, and invasive species infestations.
- The range of species will likely shift, altering the composition of trees and shrubs suitable for Columbia's climate—for better or worse.

Agriculture

- Heavier rains in the spring may challenge crop establishment and increase their susceptibility to fungal and bacterial disease.
- Increasing summer drought and warmer temperatures may stress livestock and crops. More stress on crops from climate change impacts can lower their defenses against pests and disease.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

BUILT ENVIRONMENT

Housing

- With warmer temperatures, especially in the summer, there will be more demand for air conditioning and cooling features that offer relief from heat. Energy costs will likely increase as a result.
- More heavy rainfall may increase the risk of local flooding, potentially exposing over 1,000 residential structures, including five public housing communities, to flooding impacts that could include sanitary sewer backups.

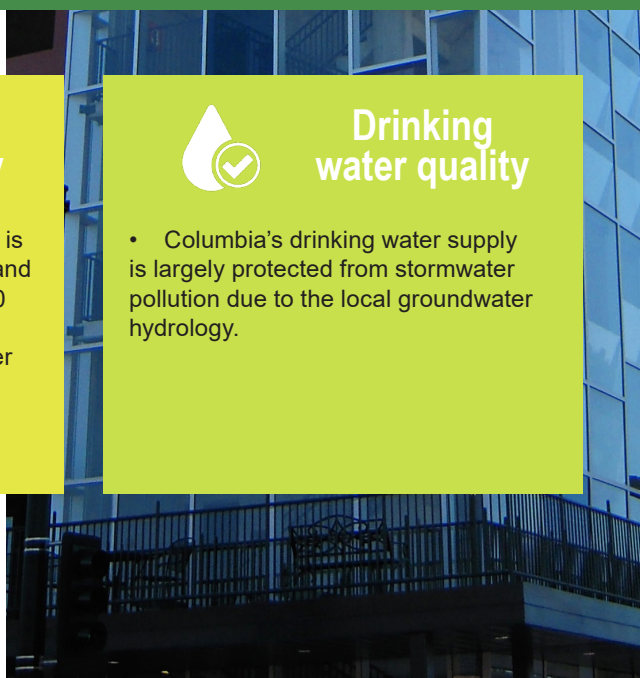
Stormwater management

- The city's stormwater infrastructure may not be able to handle the amount of runoff that is expected in the future, and considerable resources would be needed to make needed upgrades.

Transportation

- Flooding is not a significant concern for Columbia now, but more heavy rain events in the future may increase the risk of local flooding, potentially blocking roadways and trails. The high reliance on personal vehicles and limited transit services across the metro area limits residents' options for getting around, especially during times of extreme events.

WATER SUPPLY AND QUALITY



Surface water quality

- Several of Columbia's streams have existing water quality concerns. More heavy rain events will increase stormwater runoff, which can negatively impact water quality in Columbia's streams and lakes. In turn, this could harm habitats and limit recreational opportunities.

Drinking water supply

- Columbia's drinking water supply is currently reliable, but the city's demand is expected to nearly double by 2040 due to population growth. Warmer temperatures and increasing summer drought may also increase demand during the summer.

Drinking water quality

- Columbia's drinking water supply is largely protected from stormwater pollution due to the local groundwater hydrology.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

ENERGY, MATERIALS, AND WASTE

Energy

- Columbia's electricity service is most vulnerable to more frequent extreme weather events in the future. Columbia Water & Light, the City's electric utility, operates 8 substations throughout the service territory with 62 distribution circuits that serve customers at the 13.8-kilovolt (kV) level. The system has ample capacity to meet customers' electric needs during normal operating conditions. However, during emergency situations, there is not enough redundancy within the system to ensure service to all customers. More frequent extreme weather events may increase the risk of longer, sustained power outages for the City's electric customers.

Solid waste

- The greatest area of vulnerability in Columbia's solid waste management system is access to the Columbia Landfill. Currently, Peabody Road is the only vehicular access route to the landfill. The road crosses a bridge over Hinkson Creek, which is designed to pass a 100-year flood event. This access route has not previously been impassable from flooding, but as climate change impacts increase heavy rain events, access may be hindered if the bridge is damaged. While Rogers Road may offer an alternative route, it is an unimproved gravel road and would also likely be flooded where it crosses Hinkson Creek to the north.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Next Steps to Increasing Columbia's Resilience

The outcomes of this vulnerability assessment are being used to inform the development of strategies to prepare for and adapt to anticipated climate change impacts. The Climate Action and Adaptation Plan will specifically address and prioritize the areas of highest vulnerability. Where vulnerability is ranked low, the Task Force and City may still include adaptation strategies in the current CAAP, or may instead choose to monitor the situation over time and consider adding adaptation strategies if needed during a future CAAP update.

BUILT ENVIRONMENT:
HOUSING, TRANSPORTATION, & STORMWATER MANAGEMENT

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to…

Housing

MEDIUM-HIGH

Warming temperatures will likely increase demand for air conditioning, which most homes and apartments have, but the increase in energy costs may be difficult for households, especially low-income ones, to bear. Heavier rains may cause more local flooding, which could cause damage and limit mobility for some neighborhoods in more flood-prone areas of the city.

Transportation

LOW-MEDIUM

Flooding is not a significant concern for Columbia now, but more heavy rain events in the future may increase the risk of local flooding, potentially blocking roadways and trails. The high reliance on personal vehicles and limited transit services across the metro area limits residents' options for getting around, especially during times of extreme events.

Stormwater management

MEDIUM

The city's stormwater infrastructure may not be able to handle the amount of runoff that is expected in the future, and considerable resources would be needed to make needed upgrades.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Housing

Of the 46,184 occupied housing units in Columbia, 47% are owned by residents and the remaining 53% are rented [1]. In recent years, the number of multi-family housing units in Columbia has been rapidly increasing. This trend is considered to be driven by relatively rapid growth of the Columbia metropolitan area population, which increased by more than 11% between 2010 and 2016 [2]. During that same period, total enrollment at the University of Missouri Columbia increased by approximately 2.5%, accounting for some, but not all, of this change [3]. Also driving this trend may be changing expectations and desires among students for off-campus housing with amenities in close proximity to campus, as well as relatively low permitting costs. Annual population growth in Columbia is anticipated to slow slightly in the future, but will likely maintain a rate that would continue driving the construction of multi-family housing.

The average Columbia resident earning the median annual income for the region spends 26% of their income on housing costs, which is slightly under the national average. Lower-income households whose annual income is 80% of the regional median income—representing about one-third of Columbia's community—spend 32% of their income on housing [4]. The Columbia Housing Authority helps low-income households overcome this cost burden by providing subsidized housing or affordable housing vouchers to over 1,900 households in Columbia and Boone County, representing 9% of the city's rental market [5]. Meanwhile, the City of Columbia has been working to increase investments in historically under-resourced neighborhoods and help low- and moderate-income households build wealth through its first-time home buyer assistance program [6].

Warmer temperatures and more cooling needs

Climate change is expected to increase air temperatures in Columbia, with summertime highs reaching nearly 104°F and nightly lows staying above 80°F by 2080 [7]. Asphalt and other features in the urban environment may make temperatures warmer in the city due to the urban heat island effect. Under these conditions, there will likely be greater demand for homes and apartments with air conditioning (A/C), natural shading, passive cooling design, and other features that provide relief from the heat. Residents may use A/C more often, leading to increased energy use, higher household cooling costs, and greenhouse gas emissions. Larger A/C units with more capacity may be needed to counteract extreme heat, but these units may be less efficient on days when that capacity is not needed. Good insulation in homes and apartment buildings will be needed to maximize efficiency and reduce unnecessary costs; cooler roofs and other strategies can also help. Households with lower annual incomes may be less likely to have air conditioning and may need financial assistance to install and operate air conditioning units and improve insulation in their homes.

Heavier rainfall and flooding

Columbia is also expected to have more frequent heavy rainfall events in the future, which will increase the risk of local flooding to homes and apartment buildings, especially those located in flood zones [7]. Structures that are sufficiently elevated above average flood levels in the current climate may not be high enough for the larger floods that are expected to occur in the future. Thirty residential structures are located in the floodway, but about 300 more are in areas at risk of flooding during bigger events that have historically happened every 100 years [8]. A total of 1,050 residential structures, including five public housing communities, are at risk of being affected by 500-year flood events [8]. Flooding may cause sanitary sewer backups around some residential structures, potentially making them uninhabitable until water recedes and the area is cleaned up. Heavy rain events will also require larger gutters, downspouts, bioswales, and other on-site infrastructure to manage higher volumes of stormwater.

There are five public housing communities located in areas at risk of being affected by floods that have historically occurred every 500 years: Jesse Wrench, Lower Jesse Wrench, Frank Coleman, Oak Towers, and Bear Creek [8]. Lower-income residents may face challenges in recovering from flooding if they do not have insurance or sufficient resources to fix damages to their home or property.

Lynn Street Cottages and the Columbia Community Land Trust

The City of Columbia has been working alongside neighborhood and community members to redevelop the block of Garth, Sexton, Oak, and Lynn with affordable housing and improved infrastructure. The project includes the development of eight affordable owner-occupied homes with near net-zero energy usage design and universal design features. The homes were developed in a cottage housing style arrangement to increase the density of the development. The development also included significant stormwater improvements to benefit the surrounding neighborhood.

The Lynn Cottages development also coincided with the City's creation of the Columbia Community Land Trust (CCLT). The CCLT is a separate 501(c)3 with a governance structure that includes membership from the community at large, neighborhood members, and CCLT homeowners. The CCLT's main purpose is to steward the City's investments in affordable housing, which will be done by maintaining ownership of the land beneath the homes and authorizing its approved use through a 99-year ground lease. The CCLT will ensure the homes remain affordable, owner-occupied, and well-maintained for generations to come. This kind of long-term planning is especially important as we prepare for anticipated climate change impacts.

Transportation

Columbia's residents mostly rely on private vehicles to get around. Over two-thirds (78%) of residents drive alone to work, 9% carpool, 5% walk, and only 1% take public transit [9]. The annual cost of car ownership is over 18% of the average Columbia resident's annual income [4]. Columbia's public transit system is relatively small compared to cities of similar size due to budgetary constraints. Columbia is not alone in this situation—public transportation is poorly funded statewide. Columbia's pedestrian infrastructure includes 555 miles of sidewalks in the metro area, but funding constraints have also left some neighborhoods without any sidewalks, possibly inhibiting mobility and accessibility to transit, and raising potential safety concerns during flooding events.

Under future climate conditions, heavier rain events may pose a higher risk of flooding and damage to transportation infrastructure [7, 10]. Local street flooding may become more widespread if stormwater pipes prove too small to handle heavier rain events. Roads will need to be designed with larger pipes and inlets to efficiently move stormwater off the streets, which could increase costs for construction and ongoing maintenance. Heavier rains are likely to destabilize streambanks and increase erosion, threatening bridges, trails, and other structures along waterways. These impacts will require more labor and equipment to clear rock, mud, and debris and repair damaged infrastructure—all of which increase costs. Flooding also affects walking and biking, especially on trails built in floodplains. Since bike lanes are typically built close to street gutters, they may be unusable if streets are flooded. Roadways are not expected to be significantly impacted from erosion since it is currently a minor issue and mudslides are extremely rare.

Meanwhile, warmer temperatures and extreme heat may weaken pavement and other types of material, lower long-term durability, and require more maintenance. Warmer temperatures may have negative health impacts on people who use active transportation or public transit, making it more difficult for them to get around. On the other hand, warmer winters in the long term may mean fewer instances of freezing and thawing and less demand for some types of maintenance.

Columbia residents who rely on walking or biking, who do not have a personal vehicle, or who cannot drive may be more exposed to extreme heat and poor air quality from smog or airborne allergens. People with respiratory or cardiac conditions, older adults, pregnant women, and children may be especially sensitive to these conditions. Demand for Go COMO fixed bus routes, Para-Transit, and Tiger Line may increase among these community members. During severe rain events, especially when transportation infrastructure is damaged or service is interrupted, people with limited mobility including older adults and people with disabilities may need additional Para-Transit services to get to places of shelter and address basic needs. The sparse nature of the transit system could be a significant liability during such events.

Regional growth and development

Columbia's population grew by nearly 40% between 2000 and 2016 (from 84,531 to 117,165) [2]. The city is projected to continue growing by approximately 1.5% each year to exceed 200,000 by 2050 [14]. With this growth has come inner city redevelopment and increased housing prices, which could push lower-income and minority populations to the fringes of the city where there are fewer resources, transportation options, and walkable or bikeable infrastructure.

Stormwater management

Columbia's existing stormwater infrastructure will likely be challenged by more frequent and higher intensity storms due to the age and condition of structures and pipes, though much of the infrastructure has yet to be visually assessed for its conditions [11]. Extreme events may lead to more flash flooding with higher volumes of water, which will be difficult for undersized pipes to handle. These events may lead to stormwater infrastructure failures, which have occurred in recent years [12]. Since Columbia's sewer infrastructure is separate from its stormwater drainage infrastructure, it is less vulnerable to contamination during heavy rain events compared to St. Louis, Kansas City, and other cities that have combined systems [13]. Still, the City's stormwater infrastructure will need greater capacity to manage the projected heavier flows, and some houses may be affected by sewer backups during heavy rains.

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OPEN SPACE AND AGRICULTURE

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to…

Trees and open space

LOW-MEDIUM

A warming climate and drought will stress trees, and provide more favorable conditions for disease, pests, and invasive vegetation that could be difficult to contain and manage. Existing habitats will be increasingly threatened under future conditions.

Agriculture

MEDIUM

Increasing drought, warmer temperatures, and changes in precipitation threaten the quality and quantity of crop yields and make crops more prone to pests and disease. However, technologies and innovation offer the potential for more resilient crops. Transitioning to different crops suitable to the new climate also remains a possibility.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Trees and open space

Across the City of Columbia, approximately 36% of land has tree canopy cover, according to the Urban Forest Master Plan [1]. A broad range of species is represented in this area, including upland species like oaks, maples, and hickory, and lowland species like sycamore and willow, as well as non-native and invasive species like elm [1].

Along Columbia's streets, the trees found in right-of-ways are considerably diverse, with the most common species being eastern redbud (8% of the inventoried population), ash varieties (12%), American sweetgum (4%) and sugar maple (3%) [1]. Nearly three-fourths of Columbia's street trees are in fair condition, meaning that additional stressors may worsen their conditions [1].

Columbia also has 3,375 acres of parks and green spaces and over 64 miles of trails in the community-wide system [2].

Average temperatures are expected to increase in Columbia as they will across the Midwest. By 2050, average temperatures will be 4°F higher or even warmer [3]. As temperatures warm, hardiness zones will change. Growers use hardiness zones (1 to 10), which are based on the average minimum temperature in the winter, to determine which plants are most suitable to the local climate. Columbia is currently in hardiness zone 6a (average annual minimum winter temperature of -10 to -5°F) [4]. Between 2000 and 2010, some parts of Missouri went up one hardiness zone level, and in the next 30 years, most of Missouri is projected to be in Zone 7 with an average minimum winter temperature of 1 to 10°F [5]. By 2070, hardiness zones may shift even more as minimum annual temperatures

in Missouri may increase by 7 to 11°F or more compared to the 1971-2000 average [6]. With these changes, some species of trees and shrubs may no longer be suitable to plant along Columbia's streets and in parks and open spaces, while some cold-intolerant species may become suitable. The net change in species suitability may impact the biodiversity of trees and shrubs—for better or for worse—compared to what Columbia's climate currently supports.

Columbia's urban landscape could potentially exacerbate the negative impacts from warmer temperatures. The urban heat island effect is the tendency for developed urban areas to be hotter than surrounding rural areas because roads, buildings, and other dry impermeable surfaces have replaced open land and vegetation. Across the U.S., the urban heat island effect has led to an average increase in urban temperatures of 5.2°F [7]. There is some indication that the urban heat island effect may be occurring in Columbia as well [8]. In a warming climate, resources may be needed to plant more trees as well as maintain current trees to help mitigate the urban heat island effect.

Periods of extreme heat and summertime drought are expected to become more common in Missouri, which will make it more difficult to establish new plantings and may reduce survival rates. Columbia experienced the impact of drought in 2012 when some trees died due to low soil moisture and high soil temperatures [9]. More staff time and resources will be needed to water and maintain new plantings, add more mulch to surround trees, and replace plantings if they do not survive. These impacts will likely increase maintenance and operational costs. Species that are more tolerant to dry conditions—including hawthorn, swamp white oak, Kentucky coffee tree, and eastern red cedar—may fare better [10].

Plants and trees are more susceptible to disease and insects—such as oak wilt and the non-native, invasive Emerald Ash Borer—as a result of warming temperatures and drought, which stress them [11]. Thousand cankers disease, which is lethal to black walnut trees, is also of concern for potentially causing economic losses, but it has not yet been observed in Missouri [12]. Oak wilt is a lethal fungal disease that especially affects red oak species and has been observed in Boone County in recent years [11].

Invasive species that have been observed in Columbia's parks and public right-of-ways are listed below.

Species of significant concern:

- Bush honeysuckles
- Callery or Bradford pear
- Common and cut-leaved teasel
- Japanese honeysuckle
- Japanese hops
- Japanese knotweed
- Johnson grass
- Reed canary grass
- Sericea lespedeza
- Wintercreeper

Other species:

- Autumn olive
- Black locust
- Burning bush
- Crown vetch
- Multiflora rose
- Musk thistle

While Emerald Ash Borer has not yet been observed in Columbia, infestations have been confirmed in counties just to the south of Boone County, making it likely that Emerald Ash Borer will spread to Columbia in the coming years [13]. In a warming climate, fewer instances of extremely low temperatures will likely allow Emerald Ash Borer populations to grow and spread. On the other hand, with more extreme weather, this insect may be less able to withstand cold snaps when they do occur [14]. In addition, once average highs exceed the current range that Emerald Ash Borer populations require to survive, these warm temperatures may limit their spread and survival [15]. In 2014, the City of Columbia leveraged a Tree Resource Improvement and Maintenance (TRIM) grant from the Missouri Department of Conservation to inventory ash trees in public spaces and develop an Emerald Ash Borer management plan in preparation for a potential infestation [16]. In addition, the City Parks Department is updating its inventory of ash trees in city parks. The statewide Emerald Ash Borer Action Plan represents another source of support to aid Columbia in preventing and preparing for Emerald Ash Borer [17].

Meanwhile, increased stress and potential loss of vegetation creates more opportunities for non-native and invasive plants to become established, and invasive plants may be able to adapt to new conditions faster than native plants can [18]. Even though native plants and ecosystems have adapted to changing climates in the past, the rate at which the climate is currently changing is projected to be faster than the historical rate at which these plants can adapt. The habitat quality of Columbia's natural areas, riparian corridors, and right-of-ways has already been compromised by invasive vegetation and has hindered the City's ability to manage these areas; climate change impacts will likely exacerbate these issues. These areas will require active management to build more biodiverse and resilient vegetation and wildlife communities that are able to withstand climate change impacts and outcompete invasive species.

Climate change also presents some opportunities, such as a longer planting window and a longer growing season, but more extreme conditions may counteract these possible benefits.

Community action to remove invasive bush honeysuckle

In 2016, members of the East Campus Neighborhood Association came together to remove invasive bush honeysuckle from their neighborhood. Bush honeysuckle interrupts the function of our natural ecosystems by outcompeting native vegetation, reducing biodiversity, and preventing forest regeneration. These impacts are exaggerated by climate change and will likely result in a less resilient community.

The group of thirty neighbors worked together to remove as much bush honeysuckle from their yards as possible. The only existing bush honeysuckle in the neighborhood was found along steep hillsides. The neighborhood partnered with the Missouri Department of Conservation on a wildlife diversity grant that awarded $11,000 to hire a forestry consultant to remove and treat the remaining bush honeysuckle. This type of partnership with the conservation department is unprecedented and exemplifies Columbians' enthusiasm for being good stewards of our land, water, and wildlife resources.

Agriculture

On the 1,171 farms in Boone County in 2012, farmers most commonly grew soybeans, hay and other forage, corn, and winter wheat, and raised cattle and pigs, among other livestock [19]. The average farm had $44,564 in sales that year [19]. In total, agriculture, forestry, and related industries contributed $1 billion in sales to Boone County's economy in 2016 and represented over 6% of jobs [20].

As the climate changes, temperatures will increase in Columbia and change frost timing. It is projected that the last spring frost will happen one week earlier by 2050 than it does today, and the first fall frost will be slightly later [8]. Under these conditions, the timing of the growing season may shift and hardiness zones will continue to change. Farmers may have to adjust planting schedules and change or diversify crop types to adapt to these changes.

Warmer temperatures, especially during the summer, will likely place more stress on livestock and crops. Cows, for instance, tend to eat less food and grow more slowly in hotter conditions, and corn yields are projected to decrease with warmer summers [21]. Although longer growing seasons, combined with more carbon dioxide in the atmosphere—which acts as a fertilizer for plants—could increase yields of some crops, long-term agricultural productivity is expected to decline as the cumulative negative impacts of climate change offset these short-term benefits [22].

Ozone smog may increase with warmer air temperatures, and high ozone levels can slow plant growth and reduce yields of soybean and winter wheat. In some areas of Missouri, ozone levels have been high enough to potentially reduce crop yields [21]. High ozone levels can also harm lung and heart health. In Boone County, there were 13 days between 2012 and 2014 when air quality was considered unhealthy for sensitive populations such as older adults, children, and people with respiratory disease [23]. Farmworkers may be more exposed to ozone smog because of the time spent outdoors.

Increasing summer drought could stress crops and lower the quality and quantity of yields. Farms growing corn may be more vulnerable to drought than soybean and wheat farms, but using drought-tolerant varieties can increase resilience to these conditions [24]. Drier conditions in the summer are expected to reduce soil moisture, which could lower agricultural productivity and increase the demand for irrigation [25]. The availability of water resources for irrigation may become a concern in the future as Columbia's population grows, especially if there are periods of prolonged drought.

Spring and fall precipitation is projected to increase in Columbia [8]. For agriculture, heavier rains during the spring can disrupt planting schedules, make it difficult for crops to become

established, and make diseases from fungus or bacteria more likely to occur. Addressing these impacts may require more labor and increase costs to farms.

All of these impacts from climate change can place more stress on crops, making them **more susceptible to pests and diseases**. Recent testing submissions to the University of Missouri's Plant Diagnostic Clinic suggest that corn, soybean, and wheat are all susceptible to disease, but disease prevalence may fluctuate from year to year and throughout a single growing season as environmental conditions change [26]. The Japanese beetle is one pest of concern. Even the potential benefit of larger yields from higher levels of carbon dioxide may be offset, as these conditions can lower plants' defenses against Japanese beetle and other insects, ultimately causing more damage than under current climate conditions [27]. Meanwhile, warmer temperatures and increased carbon dioxide may cause insect populations to grow and new types of pests to become problematic. Japanese beetles in particular may be more likely to survive and cause more damage to soybean yields as the optimal time period for feeding on leaves is projected to increase nearly threefold by 2050 [28].

Growers will likely need to plant drought- and pest-resistant crop varieties, implement water conservation measures, use more efficient irrigation strategies, or take other actions to adapt to future conditions. Those with limited resources may need financial assistance to continue their agricultural livelihoods. As climate change impacts may reduce crop yields, farmers in Columbia may face economic challenges. In addition, food production in Missouri, across the U.S., and beyond may decrease, leading to increases in food costs for the Columbia community.

Urban agriculture

In a city like Columbia, the abundance of people and access to irrigation create an opportunity for fruit and vegetable production. Small acreages managed with intensive practices can yield an extremely high volume (and value) of agricultural products [29]. The potential for well-organized agricultural practices to produce a significant amount of a city and a region's food supply has proven by "The Intervale," a 350-acre farm in Vermont that has helped to build a wide network of growers, distributers, and eaters in that region. Many labor-intensive crops are particularly well-suited for an urban production setting.

Backyard gardens and community gardens provide a distributed production model that engages a lot of people. The benefits include not only the direct yields from the gardens, but also a range of secondary benefits such as outdoor education, beginning farmer training, community safety via passive neighborhood watch, pollinator biodiversity, soil health/water holding capacity, and much more. Collaboration on urban gardens can build social cohesion, which enhances community resilience to climate change and other stressors.

The Columbia Center for Urban Agriculture, Community Garden Coalition, Grow Well Missouri, Columbia Farmers Market, and others are working on many urban agriculture and farmer projects like those mentioned above. One specific example is the Agriculture Park; phase one construction is scheduled for 2018. This project has the potential to bring together many of the stakeholders in the farming, food service, education, health care, and civic sectors.

Urban gardens will need to be ready for the climate change impacts that will face all local agriculture, and look for ways to use water efficiently, but they can also enhance food security and contribute to climate resilience in other ways.

Native roadside vegetation

The Public Works Department has partnered with the Sustainability Office to begin converting non-native right-of-way vegetation to native plants. These sites consist of green space in roundabouts, medians, and along our roads. Native habitat patches, oftentimes consisting of glade- or prairie-adapted wildflowers and grasses, typically require mowing only once per year once established, while non-native vegetation needs regular mowing, weed-eating, and blowing. Less maintenance with motorized equipment reduces the carbon emissions generated from these activities. Vegetation along roundabouts and along our roads also helps to manage stormwater, which will be important as heavy rain events happen more often.

Thus far, Public Works has converted several sites to native vegetation and is measuring the effectiveness of this strategy to conserve resources and provide habitat, with the technical and logistical assistance of the Sustainability Office. Public Works has also hired staff to map and assess all other public right-of-way property to determine the number of acres suitable for conversion. In conjunction with this effort, Public Works staff are developing an integrated vegetation management plan (IVMP) that will guide Public Works to manage noxious weeds and invasive vegetation in these areas as well as to support biodiverse habitat patches to benefit wildlife, such as monarch butterfly and native bee populations that have faced severe declines in recent years.

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WATER SUPPLY AND QUALITY

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to…

Drinking water supply and drought

LOW-MEDIUM

While warming temperatures, increasing drought, and other changes in precipitation may limit water resources and increase demand, Columbia's water supply is likely sufficient to meet demands even under future conditions, though investments may be needed to expand water infrastructure.

Surface water quality

LOW-MEDIUM

More heavy rain events will likely negatively impact water quality in Columbia's streams and lakes, which could harm habitats and limit recreational opportunities. However, Columbia's drinking water supply is largely protected from stormwater pollution due to the local groundwater hydrology.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Drinking water quality

LOW

Since Columbia's drinking water source is well-protected from stormwater pollution, it is unlikely to be harmed by more heavy rain events in the future. While the city's drinking water currently exceeds quality standards, some activities unrelated to climate change may pose a degree of contamination risk.

Drinking water supply and drought

Columbia residents use approximately 5 billion gallons of drinking water each year. Since the early 1970s, the city's total daily demand for water, on average, has gradually increased by about 7 million gallons partly due to more customers as the city's population has grown [1]. However, the increase in demand has been contained thanks to water conservation efforts, as the average Columbia resident now uses less water per day than in the past [1].

Columbia draws its water supply for residential, commercial, and irrigation uses entirely from the McBaine aquifer—a portion of the Missouri River alluvial aquifer that is located in an area protected by a levee system managed by the McBaine Levee District. Columbia's annual use is about one-tenth of the 44 billion gallons of water stored in the McBaine aquifer [2]. Columbia pumps its water from the aquifer through 15 wells dispersed across an area known as the McBaine Bottoms and treats the water before delivering it to residents [2]. But the geology of the aquifer makes some of the water inaccessible—meaning there is a natural limit to drinking water supply from the aquifer. In addition, as we withdraw water from the McBaine aquifer, it has to be regularly re-charged or replaced by precipitation, the Missouri River, and other surface waters [3].

The Missouri River and its floodplain also provide water for over half of Missouri residents, not to mention the residents in the nine other states that are partially or fully located in the Missouri River watershed [4]. Withdrawing water from the river for different needs—from residential drinking water to agricultural irrigation—must be balanced with keeping water in the river for downstream communities, groundwater recharge, and other natural ecosystem functions.

Although Columbia considers its current supply reliable and the City has a backup storage of water for emergencies, Columbia's water demand is projected to grow in the future [5]. By 2040, peak daily water demand is expected to be nearly twice as much as the demand in 2016 [1]. Climate change will also bring new risks. For example:

- **Increasing drought:** In the future, as summer drought becomes more common across Missouri and the Midwest, water management in the Missouri River watershed will become more challenging [6]. Under drier conditions, there may be less water available in reservoirs along the Missouri River and its tributaries, which are important to managing streamflow and contribute to recharging of the McBaine aquifer [4]. The change in precipitation patterns may also reduce aquifer recharge. The result may be limitations on Columbia's water supply, meaning less water may be available for the community's irrigation needs in the summer.
- **Warmer temperatures:** By the 2050s, average temperatures in Columbia will be regularly above what has been considered normal since 1970 [7]. Warmer temperatures will increase evaporation of surface water, reduce soil moisture, and increase demand for irrigation.
- **Heavier rain events:** Projections of future precipitation show that we can expect more frequent heavy rain events [7]. These events may pose a higher risk of flooding, which can damage water infrastructure and disrupt the delivery of drinking water to residents. Although the City's water production plant and wells are protected by levees that are actively managed and have already undergone upgrades to protect against flooding, they are still vulnerable to extreme flooding events like those that occurred in 1993. In addition, flooding can damage or inundate roads, limiting access to these facilities.

As water demand increases and climate change impacts may place more stress on infrastructure and facilities, it is important for regular maintenance and improvements to be completed to maximize efficiency and supply. To this end, the City assessed the condition of infrastructure at the McBaine Water Treatment Plant, well field, and the West Ash Booster Pump Station in 2016 and incorporated the needed equipment replacements and upgrades identified in the assessment into the water utility's capital improvement plan.

Three types of customers in Columbia have the greatest water needs and may be negatively impacted by water supply constraints: 1) industrial customers, such as Columbia Foods, 3M, and Linen King; 2) hospitals and healthcare facilities, including Boone Hospital and the Veterans Administration Hospital; and 3) educational facilities, including Columbia Public Schools and The University of Missouri.

Surface water quality

Columbia's nearby surface water bodies include over 100 lakes and approximately 300 miles of streams, including its six major streams: Hinkson Creek, Hominy Branch, Grindstone Creek, Gans Creek, Little Bonne Femme, and Flat Branch [8].

When precipitation does not soak into the ground, it runs off as stormwater into Columbia's storm drain pipes and is discharged into the nearest waterway, such as Hinkson Creek, Flat Branch Creek, or Bear Creek—all of which eventually flow into the Missouri River. This stormwater is not treated, meaning that any oil, grease, pet waste, chemicals, fertilizers, and other pollutants on roads, sidewalks, lawns, and the urban landscape can potentially contaminate our waterways, decreasing surface water quality. Some of the streams running through Columbia, including Hinkson Creek, Hominy Branch, and Gans Creek, as well as some lakes have been designated as impaired waterways by the U.S. Environmental Protection Agency due to water quality concerns [8]. Restoring these waterways to a better condition is essential to supporting vibrant, healthy ecosystems as well as healthy human populations. To reduce pollution from stormwater runoff and protect surface water quality, the City of Columbia, Boone County, and the University of Missouri work together to develop, implement, and enforce a stormwater management program and plan.

As the climate changes, more heavy rain events in Columbia may increase the risk of pollution from stormwater runoff, which is expected to wash more nitrogen and phosphorus from agriculture and other activities into nearby streams and lakes, contributing to more algal growth that can be toxic [9]. Heavier rain may cause flooding, which can also increase the risk of surface water pollution by causing overflows at waste treatment plants. These impacts could potentially expose more people to contaminated water in their recreational use of streams and lakes. Exposure to contaminated water may lead to increased incidents of water-borne diseases.

Heavier rain events may also destabilize and erode stream banks, especially if there is little vegetation to hold the soil in place. Erosion causes sediment to enter streams, reducing surface water quality and harming habitats.

Drinking water quality

Columbia's drinking water supply is largely protected from stormwater pollution due to the groundwater hydrology of the McBaine Aquifer, which collects water from precipitation that has been naturally filtered through the Earth's surface. The current quality of Columbia's drinking water exceeds the federal standards for lead, copper, fluoride, and other regulated substances [10]. However, several activities and infrastructure unrelated to climate change pose a contamination risk, including tampering with wells, seepage from the city's wastewater treatment discharge wetlands, petroleum pipelines running through the well field, and land use activity [11].

Photo credit: Boone County

City spotlight: Hinkson Creek

Hinkson Creek flows through Columbia. It has experienced water quality problems like those in other urban area streams; these include contamination from urban stormwater flows and siltation from nearby construction sites [12]. In some places, particularly in the upper watershed, its banks have been scoured by high-velocity flows after heavy rains, which is expected to occur more often as the climate changes [13].

The University of Missouri has hosted a monitoring project on the creek. Climate stations, stream gauges, and sediment samplers were put on five bridges [12]. This project was aimed at helping to understand how Hinkson Creek responds to precipitation events. This kind of information will be useful for better understanding how the creek and surrounding areas will be impacted by climate change in addition to land use change.

Today, an effort is underway to improve water quality in Hinkson Creek by using a science-based approach guided by a local stakeholder committee. It assesses the entire stream system, including the creek and other parts of the watershed. Improving the ecosystem should help support the return of the biological community to a fully functioning level as well as address other pollutants that may be contributing to water quality issues. A Collaborative Adaptive Management (CAM) approach is being used to allow a wide range of actions to be investigated. Each of these actions is expected to contribute to reaching the water quality goals; some of these activities may reduce peak stormwater runoff, others may reduce the pollution in the runoff; both can contribute to the solution by improving the water quality and supporting the biological community. By learning as we implement actions, we hope to find the most effective approaches to address the water quality challenges in the watershed.

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HEALTH, SAFETY & WELL-BEING

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to…

Heat stress

HIGH

Warmer temperatures and more extreme heat may lead to higher risk of heat-related illness.

Air quality

HIGH

More days of poor air quality and greater exposure to allergens could exacerbate respiratory illnesses.

Vector-borne diseases

HIGH

Warmer temperatures may increase vector-borne diseases like West Nile Virus and Lyme disease.

Mental health

MEDIUM-HIGH

Exposure to more climate-related disasters may lead to more anxiety and other mental health consequences.

Vulnerability Ranking

LOW | LOW-MEDIUM | MEDIUM | MEDIUM-HIGH | HIGH

Who is most at risk?

"Every American is vulnerable to the health impacts associated with climate change." [1]

In general, children, older adults, women who are pregnant, outdoor workers, those with pre-existing illnesses, and those with weak social ties are more vulnerable to climate change-related health impacts. Low-income communities may have fewer options to respond and prepare for impacts, and may not have access to quality healthcare. The elderly, people with disabilities and mobility impairments, or families with mixed immigrant status may be less likely to leave their homes to seek aid. Columbia residents with Limited English Proficiency, which comprise of approximately 3.5% of the population, may need additional assistance to access information and prepare for and respond to health impacts [2]. The City is currently undertaking a community health assessment that will analyze primary and secondary data on various health issues to inform planning efforts.

Rising temperatures and heat stress

Across Missouri, by the 2050s, 10 to 20 more days per year will have highs over 95°F compared to 2016 [3]. By late century, Columbia could see maximum daily highs of 104°F, with summer nights that don't dip below 80°F [4].

Between 2013 and 2016, there were 20 reports of heat-related illnesses and three heat-related deaths in Boone County [5]. Higher temperatures and more extreme heat days could increase the risk of heat stress and heat-related illnesses, especially among people who already have certain health conditions, live in buildings without air conditioning or cannot afford it, or experience homelessness. Additional public cooling centers, beyond the 9 that are currently available, may be needed to accommodate more people [6]. With greater cooling demand, households and businesses may see a rise in their energy costs in the summer. More low-income households may need financial assistance to cover higher costs, placing greater demand on an already tight public services budget in Columbia. Additional support may be needed for the Voluntary Action Center to continue providing air conditioning units to low-income residents.

Outdoor workers—including construction crews, farmworkers, landscapers, as well as City on-site inspectors, environmental health workers, and street maintenance crews—could be more exposed to extreme heat. To protect these workers, certain safety precautions may need to be taken, such as starting work shifts earlier in the morning to avoid daily high temperatures or working shorter shifts (e.g., two 4-hour shifts instead of one 8-hour shift). Outdoor recreation and sporting event participants will also be more exposed to extreme heat, and may benefit from adjustments to event timing and other adaptation strategies.

With warmer temperatures and extreme heat, transportation may become more difficult for older adults; people who rely on walking, biking, or public transit; children who walk to school; or people with limited mobility. It may be harder for these groups to get to workplaces, school, and health care facilities during extreme heat events.

Extreme events

Risk to life may also increase with climate change. Flash flooding is a risk in Missouri, which poses a particular danger to people in cars on flooded roadways. In 2015, 27 people were killed by flooding in Missouri; 23 of them were in motor vehicles [17]. Climate change is expected to bring more heavy rainfall events, which increases the risk by reducing visibility.

During extreme heat, floods, drought, and other extreme or emergency weather conditions resulting in power outages, the Columbia community has higher demand for emergency response services. This requires more capacity and coordination among governments and service agencies to plan services for residents, especially meal delivery, provision of medicine, and other assistance for people with limited mobility or disabilities. In addition, extreme weather conditions make it harder for service providers to reach those in need, and to find locations for public heating and cooling centers that can accommodate more people.

Vector-borne diseases

Currently in Columbia, there is a low incidence of two of the most common U.S. vector-borne diseases: tick-borne Lyme disease and mosquito-borne West Nile virus. Between 2011 and 2015, there were three reported cases of Lyme disease and only one of West Nile virus in Columbia/Boone County [7]. Although Zika and Dengue viruses are not currently in Missouri, there is concern that they could spread north into the state under warmer conditions.

There is a greater incidence in Missouri of Rocky Mountain Spotted Fever, Ehrlichiosis and Anaplasmosis. In 2013, there were 398 cases of Ehrlichiosis and Anaplasmosis in Missouri [8].

As temperatures warm, disease spread through mosquitoes, ticks, and other vectors may become more prevalent in Columbia, as a longer warm season could increase populations of these vectors known to carry certain diseases. Across the U.S., illnesses from mosquito, tick, and flea bites tripled from 2004 through 2014 [9].

The Vector Control Specialists who help manage mosquito populations engage in physically demanding work outdoors, so they are more exposed to extreme heat. In addition, heavy and extended rains during the spring postpones vector control efforts until the rains stop, allowing mosquito breeding to go unchecked. Under these conditions, environmental and public health workers could face heavier workloads and may need additional capacity, and costs would likely increase to support these efforts.

Education programs may be needed with local health providers to ensure they can recognize symptoms of vector-borne diseases as the incidence increases. There are few local infectious disease specialists meaning diagnosis and care must often be provided by primary care or urgent care physicians.

Poor air quality, allergens, and respiratory illnesses

Between 2012 and 2014, Boone County had 13 days when the air quality was considered unhealthy for higher risk populations, such as older adults, children, and people with respiratory disease [10]. In particular, poor air quality can exacerbate asthma conditions. In 2015, there were 725 asthma-related emergency room visits in Boone County [11]. In the future, warmer temperatures may lead to higher levels of ozone smog pollution, which can harm lung and heart health [12]. Columbia may experience more days each year with poor air quality, and air quality may be worse on those high-risk days. During these times, indoor air quality will also likely be lower as ozone enters buildings through windows, doors, cracks, and other openings. Given that people spend most of their time indoors, Columbia residents will be more exposed to indoor ozone for longer periods of time and may experience negative respiratory health effects as a result of indoor exposure [13].

With warmer temperatures, the pollen season may also become longer and more severe across Missouri [12]. These changes could worsen allergy symptoms and possibly contribute to asthma attacks. Additional capacity may be needed among health services to adequately serve the community's changing needs.

Indoor air quality may also be reduced with heavy rain events, more flooding, and higher outdoor humidity that increases moisture and humidity indoors, supporting more mold, dust, and other air contaminants [14]. This may worsen asthma symptoms and increase cases of respiratory infections. Extreme weather events and flooding may heighten this risk if power outages occur and turn off heating, ventilation, and air conditioning systems, reducing air flow and humidity control [15].

Poor outdoor and indoor air quality and increased exposure to allergens could disproportionately impact people who work outdoors, spend longer periods of time indoors, or already have certain health conditions, including allergies, asthma, and other respiratory conditions. Practices and procedures may be needed to protect Columbia residents from exposure on high-risk days.

Some communities in Columbia are more vulnerable to ozone smog pollution due to higher exposure and limited resources to prevent exposure and respond to health impacts. Neighborhoods will be more exposed if there is more vehicular traffic generating air pollution, more paved surfaces increasing surface air temperatures and heightening ozone levels, and less park space, vegetation, and tree canopy coverage, which remove ozone from the air.

Implications for food security

Climate change impacts, including drought, may limit food production in Missouri, across the U.S., and worldwide. Extreme events could also interrupt transportation of food. These impacts could mean higher prices at the grocery store and farmers' markets. Lower-income households may have difficulty bearing this higher cost burden and require public assistance. In the past, Columbia has seen higher demand for public services when economic conditions change. Boone County already has high levels of food uncertainty and very high participation in the national free and reduced school lunch program relative to the rest of the state, yet low participation in the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program [18]. Additional resources may be needed to close that gap and better serve these community members in need. Meanwhile, local farmers in the Columbia area could also face economic challenges with lower yields or losses of certain crops. In addition, more extreme weather events, like heat waves and heavy rainstorms, could make it more difficult for older adults and people with limited mobility to access grocery stores.

Implications for mental health

Climate change is expected to bring more extreme temperatures and other severe weather. Even the threat of these conditions can impact an individual's mental health and the community at large, especially when they could cause loss of life, significant loss of resources, property or social support, or require relocation or other extensive changes to one's daily routine. Many people exposed to climate-related disasters experience serious mental health consequences, such as post-traumatic stress disorder (PTSD), depression, and general anxiety. It has been documented that in the wake of a disaster, instances of domestic violence and drug and alcohol abuse increase. Some studies also show a link between higher temperatures and increased rates of suicide [16]. As higher temperatures and extreme weather become more common in Columbia, it will be important for the community to have tools and strategies to handle stress when these conditions occur, and for mental health providers to have sufficient resources and capacity to prepare their patients for these changes. Affordability of mental health services is currently a challenge for many adults in Columbia, indicating that financial support may be needed in the future. In addition, further development of the mental health workforce will likely be important, as Columbia is already experiencing a shortage of mental health workers.

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Columbia CAAP Priority Action Matrix

Columbia Climate Action and Adaptation Plan

Updated May 23, 2019

This document presents implementation details for the Priority strategies and actions of the Columbia Climate Action and Adaptation Plan (CAAP). This document includes the following sections:

Acronyms

CATSO	Columbia Area transit Study Organization	PedNet	PedNet Coalition
MODoT	Missouri Department of Transportation	MEEA	Missouri Environmental Education Association
FHWA	U.S. Federal Highway Administration	HBA	Home Builders Association
NHTSA	National Highway Transportation and Safety Administration	W&L	Columbia Water and Light
GF	General Fund	MDNR	Missouri Department of Natural Resources
CMCA	Central Missouri Community Action	PHHS	Public Health and Human Services
REDI	Regional Economic Development	MO DHSS	Missouri Department of Health and Social Services
DOE	U.S. Department of Energy	ONS	Office of Neighborhood Services
CHA	Columbia Housing Authority	USDN	Urban Sustainability Directors Network
STL	The City of St Louis has implemented a benchmarking program	APPA	American Public Power Association
CDBG	Community Development Block Grant	MPUA	Missouri Public Utilities Alliance
MMSWMD	Mid-Missouri Solid Waste Management District	ESCO	Energy service company
EPA	Environmental Protection Agency	HR	Human Resources
EEC	Environment and Energy Commission	BCCC	Building construction and Codes Commissions

Transportation

#	Action	Lever	Timeframe[1]	Lead entity[2]	Potential partners	Cost	Potential Funding strategies	Key next steps
T-1.1.1	Prioritize transportation funding for Vision Zero engineering improvement projects to create safe streets for people walking, biking, and riding transit.	Policy, infrastructure	Long term	City Manager's Office	Public Works, Community Relations, Community Development, PedNet, CATSO, Bike Ped Commission, Disability Commission, MODoT, Parking, Transit	$$$	TBD	Planning for deployment in 2020, need to identify funding sources.
T-1.1.2	Revise street design standards to create streets that prioritize people walking, biking, and riding transit while also accommodating vehicles.	Policy and Infrastructure	Ongoing and Long term	Public Works	Business districts and associations, PedNet	$	Current Funding	Identify and prioritize changes to design standards, quantify cost impact Evaluate existing CIP list for "quick win" scenarios, identify longer range, higher-impact projects.
T-1.1.3	Prioritize transportation funding to achieve mode share goals.	Policy and infrastructure	Short term	Public Works	PedNet, Bike Ped Commission, CATSO	$$$$	Green Bonds, reprioritization, Grants	Evaluate funding gaps for "quick win" scenarios, work with community and municipal partners to emphasize multiple benefits of shifting modes.
T-1.2.1	Improve efficiency, convenience, and reliability of bus service and infrastructure (e.g., increase frequency, shorten wait times, construct bus stop shelters).	Infrastructure	ongoing	Public Works	MU, CPS, CoC	$$$$	Traffic Demand Management (redirect parking fees create an active transportation fee for parking), Reprioritize current funding, development fees, grants, create local gas tax.	Continue evaluation of funding and design options to maximize efficiency, develop educational materials and programs to improve public awareness of benefits and extent of transit services.
T-1.3.1	Build and maintain a network of on-street protected bike lanes on streets with speed limits above 30 mph. Build other bike facilities (bike boulevards, etc.) on streets with lower traffic/speed.	Infrastructure	Long term	Public Works, Parks and Rec	PedNet, Bike Ped Commission, CATSO, Office of Sustainability, MODoT, FHWA, NHTSA	$$$$	Traffic Demand Management (redirect parking fees create an active transportation fee for parking), Reprioritize current funding, development fees, grants, create local gas tax.	Link updates of Sidewalk Master Plan and Bike Master Plan with current funding and future renewals of the Parks Sales Tax (2021) and CIP Sales Tax (2025). Develop a Traffic Demand Management Plan/Program to fund and promote mode share.
T-1.4.1	Accelerate building sidewalks, crosswalks, and other walking infrastructure in high-need areas and to fill connectivity gaps as identified in Sidewalk Master Plan.	Infrastructure	long term	Public Works, Parks and Rec	PedNet, Bike Ped Commission, CATSO, Office of Sustainability, MODoT, FHWA, NHTSA	$$$$	Traffic Demand Management (redirect parking fees, create an active transportation fee for parking); reprioritize current funding; development fees; grants; create local gas tax	Link updates of Sidewalk Master Plan and Bike Master Plan with current funding and future renewals of the Parks Sales Tax (2021) and CIP Sales Tax (2025). Develop a Traffic Demand Management Plan/Program to fund and promote mode share.

[1] Short term is less than or equal to 5 years; Long term is 5 to 10 years, or Ongoing

[2] Could include a City department, community organization, or partnership

#	Action	Lever	Timeframe[1]	Lead entity[2]	Potential partners	Cost	Potential Funding strategies	Key next steps
T-1.4.2	Install universal design accessibility features at crossing locations to ensure the crossing is accessible for everyone (e.g., pedestrian traffic signals, audible signals).	Infrastructure	Ongoing	Public Works	PedNet, Bike Ped Commission, CATSO, Office of Sustainability, MODoT, FHWA, NHTSA, Disability Commission	$$$	Current Budgets	Evaluate current rate at which intersections are updated and ADA upgrades are made and determine if additional funding is needed to accelerate that rate.
T-1.5.1	Revise zoning codes to favor walkable, connected neighborhoods in the existing built environment, near schools, and new development.	Policy	Short term	Community Development	PedNet, CATSO, CPS	$	Current Budgets	Revise Unified Development Code.
T-1.5.2	Incentivize infill and mixed-use development (e.g., through alternative code compliance, fee waivers, density bonuses, investment prioritization, development impact fees, tax benefits).	Policy	Short term	Community Development	PedNet, CATSO, CPS, Apartment Association	$$	Reprioritize existing funding, development fee structure, grants	Revise Unified Development Code; reprioritize/restructure current development fee structures.
T-1.5.3	Revise zoning codes to encourage Accessory Dwelling Units (i.e., mother-in-law units).	Policy	Short term	Community Development		$	Current Budgets	Revise Unified Development Code.
T-1.5.4	Preserve and enhance affordable housing, especially near bus service, to prevent displacement of vulnerable populations.	Policy, management practice	Short term	Community Development	Sustainability, community housing organizations	$	Reprioritize existing funding, CDBG	Revise Unified Development Code.
T-2.1.1	Introduce a policy to replace City fleet vehicles and buses with electric and hybrid options at time of replacement, and require emissions standards, testing, and biofuel preference for any combustion vehicles remaining in the fleet.	Policy and infrastructure	Long term	Purchasing and Fleet	Water and Light, Public Works, Transit/Parking All City departments, commercial and residential developers and managers	$$$-$$$$	Current budgets, use of projected savings, leasing, grants, utility rates, private funding	Determine allowable emissions standards for remaining combustion vehicles, evaluate staff and facility capacity required for EV maintenance. Develop strategic planning group for fleet transformation.
T-2.1.2	Create EV roadmap to increase the number of electric charging stations in public parking areas (e.g., schools, parks, libraries, city-owned parking garages, near city hall) and in commercial and high-density residential areas.	Policy/Infrastructure	Long term	Water & Light	Parking Utility, Large employers, regional electric utilities, Division of Energy, Office of Sustainability	$$$	PPP, electric rate revenue, Green Bonds	Engage stakeholders to solidify priorities and structure of local charging network.
T-2.1.3	Encourage installation of EV charging capacity in single family and multifamily residences (e.g., how to address residences that lack garage access).	Policy	long term	Water & Light	Community Development, Office of Sustainability, property managers	$$	TBD	Identify market barriers and potential to address. Evaluate peer cities'

Housing, Building & Development

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
H-1.1.1	Promote and offer incentives for improving residential energy efficiency during retrofit projects that exceed existing building energy code requirements. For example, using higher performance insulation materials in order to meet new construction energy code standards.	Policy	Short term	W&L, Sustainability	MEEA, consultants, Smart Energy Solutions, HBA, W&L, Architects, Builders, Design firms, Lumberyards	$$	W&L Utility Rebates/Loans	Evaluate building codes to determine retrofit projects provide GHG benefit and exceed building codes. Develop a promotional plan.
H-1.1.2	Increase energy efficiency funding options for income-qualified families (low-interest financing, on bill financing, Pay As You Save, PACE, etc.).	Policy	Short term	Utility Services	OS, Energy Efficiency for All, REnew Missouri	$	Rates, taxes, third party financing	Evaluate billing software needs, policy changes and market potential.
H-1.1.5	Require all rental housing to meet basic energy efficiency standards when license is renewed.	Policy	Short term	Offices of Sustainability and Neighborhood Services	Health Department, CMCA, Utility Services	$$	W&L Utility Rebates/Loans and CDBG funds, Community Cost Share, Green banks Inspection fees	Gather Baseline data Determine what "basic" might mean Work with Stakeholder groups Educate on examples of existing programs elsewhere.
H-1.1.7	Develop and test an energy performance rating/labelling program for homes listed for sale or upon rental license renewal.	Information/ Education Policy	Ongoing	State of MO Utility Services	Health, OS, RE Professionals, property managers, appraisers	$$	In kind promotion, PPP Customer Fee Rates (if internalized completely to Utility Services)	Promote existing program to develop market awareness/acceptance. Measure number of public scores on GBR, Number of scores used in sales, number of times scores accessed.

H-1.2.1	Provide assistance to commercial buildings above a minimum gross floor area to track energy and water usage. Require all such commercial buildings to disclose their energy and water use.	Policy	Short term
			
			Short term (voluntary/size req)
			Medium term (required)
				Sustainability Utility Services	DOE, energy professionals, REDI, Chamber of Commerce,
					
					NRDC Sustainability Commercial Partners/Champions
						$ staff
						$ incentives/assistance
						
						$-Internal
						$$-external
							Revenue from rates W&L Utility Rebates/Loans
							Grant?
								Create inventory of buildings, determine ft2 characteristics, EE and EUI. Engaging key stakeholders & potential commercial champions on engagement
								Measure ft2 audited, benchmarked, improved. Change in EUI.

H-1.2.2	Develop specific energy efficiency programs for hard-to-reach segments of commercial properties (e.g. commercial rental, restaurants, large scale manufacturing, offices, affordable multi-family housing).	Policy	Short/Long term	Utility Services, Sustainability	MEEA, DOE, REDI, business associations Advocacy Groups, Business associations, Ameren	$ staff $$$ incentives/assistance	Revenue from rates W&L Utility Rebates/Loans Grants Rates, Green Bonds, ESPC	Market study to define “hard-to-reach” segment and their improvement potential, identify and address barriers to participation. Define programs accordingly. Measure cost of project, amount of (energy reduction, $$ saved, GHG impact).
H-1.2.3	Promote and offer incentives for improving energy efficiency (e.g., insulation, energy-efficient windows, electric heat pumps) in newly constructed commercial properties. New construction incentives shall support measures for projects that exceed code requirements.	Policy, Education	Short term and ongoing	Utility Services, Sustainability	Local builders, Design/architecture firms, Sustainability Ameren	Staff - $ incentives - $$	Revenue from rates W&L Utility Rebates/Loans (Possible impact to rates) Rates, Green Bonds, ESPC	Consider implementation along with new construction residential incentives. Long term success might include increasing code requirements. Examine market and emissions reduction potential new v. existing construction. Measure: cost of enhanced project, amount of (energy reduction, $$ saved, GHG impact) compared to code built.

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
H-1.2.4	Identify funding strategies to ensure rebate budgets are sufficient to meet expanded offers and goals.	Business Practice	Short term	Sustainability, Finance, Utility Admin	Finance, REDI, Chamber of Commerce USDN, MPUA, APPA, Advocacy Groups	$	Existing funding for staff	Utility Services would need to evaluate current rebate programs and the funding available to ensure they meet expanded offers and goals.
H-1.3.1	Create a policy that all City buildings shall reduce energy usage by 20% over the next five years.	Policy, Management Practice, Education	Short term	Public Works,	W&L, ESCO, Sustainability	$$$ upfront $ ongoing staff Ongoing OpEX 0$	ESCO or other financing	Consider collective 20% rather than 20% for each building. Identify top five opportunities for energy improvement, look for crossover with other strategies. Measure using Portfolio Manager or similar metrics.
H-1.3.2	Create a policy, to be part of assigned duties and presented during new employee orientation, that City employees shall turn off lights and equipment when they are done using them.	Policy, Education	Short term	Sustainability	HR, City Manager	$ or less (Staff)	GF	Develop standards/expectations and orientation material. Measure through regular employee survey instrument regarding behavior change.
H-1.3.3	Introduce a policy that requires all new and existing municipal buildings to meet and maintain energy and resource efficiency standards (ENERGY STAR, LEED, HES or other).	Policy	Short term	Public Works	Sustainability, W&L	Upfront/Capital $$$ Staff $ Ongoing 0 <$$>	ESCO, Green Bond, Reallocation	Focus on benchmarking first and consider using defined collective energy goal for all City buildings or evaluating based on asset potential and cost.
H-1.3.4	Introduce a policy that requires all municipal buildings to be benchmarked with the current ES rating, the energy use intensity (kBTU/sqft) and the energy reduction goal. These benchmarks and goals shall also be posted on the City's website.	Policy	Short term	Public Works	Sustainability, Engineering Interns, DOE	$	Existing funding for staff	Verify building characteristics, build data management and reporting process.
H-1.4.1	Require that the City adopts the International Building Energy Conservation Codes for municipal, commercial and residential buildings as written.	Policy	Short term	BSD	BCCC and EEC, W&L, Sustainability	$	GF	Draft memorandum of understanding between BCCC and EEC. Propose collaborative project to look at implementing incentives for stretch codes.
H-1.5.1	Incentivize switching space and water heating from fossil fuel-based to electric heat pumps.	Policy, Education	Long Term	W&L	Sustainability, CHA, tenants	$ staff $$ incentives	Rates, Green Bonds	Conduct a market study, evaluate impact to customers. Measure cost of project.

Waste

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
W-1.1.1	Create a reuse program for curbside collection and purchase a warehouse to store and sell items that are not accepted by local non-profit groups.	Infrastructure	Long term then ongoing	Solid Waste	MMSWMD, Sustainability Non-profits, Volunteers, community service	$$$$ Capital for purchase or build a warehouse/building Ongoing staff $$$, some ROI	Utility fees Grants, income from resale, Grants/Co-partnerships/Small Rate Increase	Determine what items would be considered for a reuse program by contacting local non-profit groups to determine what they don't accept. Determine a location to purchase or build a warehouse/building to store and sell the items. This would have to be staffed by City employees and would be an on-going cost, so a cost analysis would need to be done Research properties find non-profits already doing it (see 1.5.3) and coordinate long term plan.
W-1.1.2	Partner with Restore/Habitat for Humanity for demolition waste pickup and reuse.	Policy	Long term	Community	Solid Waste, Historic Preservation	$	Grants, re-prioritization	Offer consultation to groups willing to divert construction and demolition waste from the landfill.
W-2.1.2	Restructure all solid waste rates to reduce the amount of waste sent to the landfill.	Policy	Short term	Solid Waste	MMSWMD, MORA	$$ $ to revenue neutral with ROI	Re-prioritization of existing revenue from Utility rates and fees	Establish planning goals, research best practices and review current rates to determine how to restructure. Conduct rate impact study, possibly with the assistance of an outside firm.
W-2.1.3	Require multi-family homes to offer on-site recycling for residents.	Policy	Short term	Solid Waste	Housing Authority	$ (most cost to developer)	Grants, re-prioritization	Draft and pass ordinance hold community workshop with developers, research other models .
W-2.2.1	Study the short- and long-term costs and benefits of a City composting program.	Information, Education	Short term then ongoing	Solid Waste	U.S. Compost Council, private composters, University, Sustainability	$-$$	Re-prioritization of existing utility fees, grants	Conduct a study (hire consultant) to review and establish a possible composting program.
W-2.3.1	Research management practices of construction and demolition waste diverted from the landfill.	Information, Education	Short term	Solid Waste	private developers	$	Re-prioritization	Learn more.
W-2.4.1	Offer positive reinforcement and indirect financial incentives to encourage businesses and residents to divert material from the landfill.	Information, Education	Short term and ongoing	Solid Waste	MMSWMD, MORA, Chamber of Commerce, Better Business Bureau	$	Grants, re-prioritization	Develop educational materials and incentive program.
W-2.4.2	Develop and enforce ordinances requiring commercial customers to recycle material streams like cardboard, paper, beverage containers, etc.	Policy	Long term	Solid Waste	Local law enforcement	$	Landfill disposal rates, citation revenue	Research best practices determine enforcement process and feasibility, draft and pass ordinance.
W-3.1.1	Research and add best practices for recycling hydrofluorocarbons (potent GHG used in refrigeration and air conditioning) in next CAAP update.	N/A	Short term	Solid Waste	MDNR, EPA, trade associations, private companies	$	Re-prioritization	Research develop education materials.
W-3.2.1	Remodel and upgrade the City's Material Recovery Facility to increase processing capacity, add sortation technology, and provide space for additional material types to be recycled, including (but not limited to) e-waste, mattresses, cartons, and household hazardous wastes.	Infrastructure	Short term	Solid Waste	MMSWMD, The Recycling Partnership, Resource Recycling, Carton Council	$$$	Grants, Capital Improvement Fund	Staff visit to other municipalities with a similar operation, hire a consultant to provide recommended technologies and facility design, find material end markets and build partnerships.

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
W-3.3.1	Conduct a comprehensive waste composition study every five years.	Information, Education	Long term and ongoing	Solid Waste	MDNR, private sector	$ (30 to 60k per year)	Landfill disposal rates	Determine material types to measure, hire a consultant or use staff to conduct waste composition study.

Energy

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
E-1.1.1	Offer community solar program through W&L.	Policy, Infrastructure	Short term	W&L/Utility Services Division (USD)	Housing developers, Solar contractors, Sustainability	$$	Utility Fees, Revenue Bond, Rates Utility fees for maintenance and staffing support of the project. The debt service payments can be met through energy payments.	Integrate into billing software, test billing process, define community and utility solar goals. Measure: subscription rate, renewable % met and GHG reduced, progress to local solar goals.
E-1.1.2	Develop and implement virtual/aggregate net metering policies and procedures with W&L to allow privately developed community solar.	Policy, Infrastructure	Short term	W&L	Sustainability, solar developers, large employers	$	Cost may be recovered through rate structure/fees.	Conduct market study, evaluate similar projects in peer cities, develop pilot → permanent program, rate structure, etc. Integrate into billing software, test billing process, define community and utility solar goals.
E-1.1.3	Install solar panels on all City buildings and sites, where feasible.	Policy, Infrastructure	Ongoing	City (Public Works)	3rd Party Lessor W&L, Sustainability, building occupant	$$/year $$$$ total project	Green Bonds Utility Fees if W&L owns/installs Part of ESCO project for existing buildings.	Formalize Council directive to Complete suitability analysis, establish “feasibility” criteria. Evaluate funding options Measure: renewable energy offset achieved, % of suitable sites developed, progress to local solar goals.
E-1.1.4	Streamline and offer expedited permitting for renewable energy installations.	Policy, Management Practice	Short term	BSD	EEC, contractors, advocates Fire/USD	$	General Fund permit fees	Complete staff review of current process. Propose improvements from internal BSD/W&L staff analysis, verify if GIS modelling can replace onsite shade analysis. Measure: Time to process/approve applications. Time for rebate check/loan closing.
E-1.1.5	Make it easier for large multi-family, commercial, and industrial customers to maximize the benefit of using their space for photovoltaics (e.g., feed-in tariff, third-party lease agreements, roof space rental).	Policy	Short term	W&L	Industrial and Large General Service Customers; Environmental Groups; 3rd party installers, Sustainability	$	Private Capital, Rates	Develop/modify policy and ordinance as needed. Establish local solar goal using IERMP guidance . Evaluate and identify large commercial and industrial customers. Measure: increase in the rate of non-residential PV installs and number of PV deals with new structure.
E-1.1.6	Require production meters on all new net-metered photovoltaic installations.	Policy, Infrastructure	Short term	W&L	MPUA	$	solar application fee	Deploy meters to support current modelling of interconnected PV systems and justify REC’s. Develop a policy or ordinance to require meters on all new Net-Metered photovoltaic installations.

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
E-1.1.7	Determine the true value and potential of customer-owned photovoltaics to the infrastructure, economics, and renewable goals of W&L. Analysis should include time of generation, capacity credit, distribution circuit support, customer characteristics, technical and market potential, etc.	Policy	Short term	W&L	Customers MPUA Division of Energy	$$$	Rates, grants, PPP	Look at relevant findings in IERMP, if any. Develop RFP for additional information needed.
E-1.2.1	Include Climate Action and Adaptation Plan priorities in Columbia Water & Light's long-range electric planning goals.	Policy	Short term	WLAB	IERMP TF & Council Climate Commission Sustainability	$	Rates	Map the alignment of W&L utility priorities, IERMP findings and CAAP goals. Identify opportunities for collaboration and areas of difference. Measure: progress in IERMP updates (2 years?).
E-1.2.2	Consider all renewable energy sources on a cost per metric ton of CO_2 equivalent basis reduction in the City's integrated electric resource plan.	Policy	Short term	W&L	IERMP TF, Sustainability, CCC	$	Existing funding	Establish system and criteria by which new energy sources/contracts under consideration are evaluated. Review may include W&L, Office of Sustainability, WLAB and CCC.
E-1.3.1	Remove 3% rate cap to allow for increased investment by Water & Light in renewable energy resources.	Policy	Short term	W&L	Legal, Finance, WLAB, Sustainability	$	Existing funding	Draft ordinance language.
E-1.3.2	Codify through ordinance Columbia Water & Light's responsibility to meet 100% renewable energy generation or purchase by 2035, including parameters for the use of Renewable Energy Credits (RECs) and equity and cost impacts.	Policy	Short term	W&L	Legal., Finance, WLAB, CCC, Sustainability, City Council	$$$$	Increase in rates as needed, securitization of contract obligations.	Examine options for meeting 100% by 2035 goal, develop H/M/L cost scenarios including rate impact, externalized cost of carbon emissions. Draft ordinance to include review of market conditions, equity considerations, definition of "renewable", use of RECs.
E-2.1.1	Develop energy storage (battery) programs for all customers to reduce peak demand, to increase electricity reliability, to improve the effectiveness of solar and other Renewable Energy options, and to establish microgrids with smart meters.	Policy, Infrastructure	Ongoing	W&L (Engineering and USD)	MPUA, NREL, interconnected PV customers, vendors.	$$ per year $$$$ - upfront $ Staff	Small projects: Private Capital, Rate funded Loan Program Large Projects: Revenue Bonds, Private Capital Some costs can be offset from income derived through ancillary grid services provided by the asset.	Investigate program options, benefit to utility, market potential. Look at possibility to revise energy storage rider program to apply to all customers and include dispatchability as benefit. Measure: peak power and energy reduced, GHG reduction, outage frequency and duration.
E-2.1.2	Ensure equitable implementation of grid resilience actions by partnering with vulnerable neighborhoods and non-governmental organizations to develop resilience hubs—community facilities that offer power and other community services during times of need. Establish criteria to screen and select locations for community microgrids to support grid and community resilience.	Policy, Infrastructure, Education	Long term	Health, Sustainability	W&L, community organizations	$$	Grant Funding, PPP, ESCO, FEMA	Develop indicators for vulnerability, engage stakeholders, develop potential action strategies.
E-2.2.1	Install meters that allow for rate structures that incentivize lower electricity use at peak hours.	Policy, Infrastructure, Education	Ongoing	W&L	Sustainability, transit, EV stakeholders	$$$$	Rates or Bond Funded Rates	Develop and implement TOU rate structure/test project to guide implementation of final, comprehensive TOU.

Health

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
HS-1.1.1	Develop and implement a plan to monitor climate change related illnesses. Utilize results in resource and policy planning, with particular focus on neighborhoods. Communicate results on a periodic basis to the public.	Management Practice	ongoing with short-term phases Short term	Public Health and Human Services	Fire Dept, hospitals, medical facilities, MU Public Health Dept., Health Care System, MO DHSS	$$	Grant to get program started and short-term funding, possibly a health foundation Existing PHHS staff could likely do the surveillance using existing resources.	Research grants and partnership opportunities. Align with CHIP. Determine if this level of health data can be monitored at the neighborhood level. PHHS staff will lead a process with appropriate partners to determine what data is available / appropriate and will draft a plan to monitor data and report results.
HS-1.1.2	Coordinate with community health improvement teams to incorporate climate change and CAAP goals into the Community Health Improvement Plan and Health Impact Assessment.	Management Practice	short-term (within 5 mo.) and ongoing	Public Health and Human Services, OS,	Health Care System, social services agencies	$ Staff Time	Existing funding	Schedule meeting with CHIP teams to exchange progress and opportunity reports. 2019 CHIP is being finalized now with CAAP goals incorporated where applicable. Five-year update would be the time the see about additional inputs.
HS-1.1.3	Review and effectively communicate emergency and evacuation plans on a regular basis to update for climate change forecasted data, paying particular attention to flooding, extended heat waves, and tornadoes.	Management Practice, Information, Education	Short term	Office of Emergency Management	Public Safety agencies, Public Health & Human Services, health care system partners, and other traditional first responders		Existing funding	Identify tool for climate change forecasted data. Work with Boone County Office of Emergency Management.
HS-1.1.4	Build City staff capacity to support community-led, neighborhood-focused resilience actions (e.g. identifying best practices, establishing resilience hubs, and implementing neighbor-based emergency response).	Management Practice, Information, Education	Short and long term	ONS (Bill Cantin), PHHS	OEM PHHS First Response Agencies Non-profits (Red Cross/Sal Army etc.	$-for training/Education programs $$$ -for physical structures/capital improvements	Grants, CIP,	Review model programs. Engage with existing ONS and Health staff working on neighborhood and resilience issues (Strategic Neighborhoods, trauma informed community/services for families and children.)
HS-1.1.5	Partner with outside agencies to offer community resilience model training.	Management Practice, Information, Education	Short term	Sustainability	PHHS, community organizations, health professionals, Neighborhood Associations, Public safety	$$	TBD	Identify existing programs, groups, neighborhood leaders. Assess needs and opportunities for integration of related CAAP priorities.
HS-1.2.1	Identify a sustainable funding source for increased utility assistance for low-income residents, including support for energy efficiency projects such as weatherization.	Policy	Short term	PHHS – Steve Hollis	Office of Sustainability, City Utility/W&L, Finance, UCS/Community Relations, CMCA	$ (costs for solely marketing CASH/HELP could be low. New utility rate/discount based on income could be much higher)	TBD	Form a work group to review possible models and prepare a report for Council consideration (currently underway).

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
HS-1.3.1	Create anti-idling policies and enforcement plans.	Policy	Ongoing Municipal policy exists	Sustainability Office/City Manager's Office	CPS, business areas (i.e. The District), city and county government	$ - Staff time, $ - communication and education materials	TBD	We would need to determine if this is meant to be community-wide, internal to city, school drop-offs, etc.
HS-1.3.2	Update property maintenance code to manage and mitigate mold or fungus.	Policy, Education	Short term	ONS	PHHS, OS, MU Extension[3]	$$		Would first need to find model programs. Staff would need guidance on how to measure, what are acceptable levels, how to determine who's responsible (tenant or property owner). Education could be done anytime with Healthy Homes.
HS-1.4.1	Form a team to develop action plans to address climate-related mental health resilience at the individual, neighborhood, and community level.	Management Practice	Long term	PHHS/OS	MU	$	Grants, existing funding.	Current priority is getting families and children access to trauma informed services. Would need to identify who would make up this team. Might be tied into HS - 1.1.4,5 where someone goes into neighborhoods and works with community to increase resiliency all around – with more than a climate related focus.
HS-2.1.1	Support organizations and schools promoting local food production and community gardens, through partnerships, funding, and educational programs including the benefits of a plant-based diet.	Information, Education	Short term	Sustainability	Columbia Public Schools, Columbia Center for Urban Agriculture, farmer's market, private schools, local farms, local chefs, local grocery stores, Health Department	$$	TBD	Expand programming at community gardens, hire garden coordinator, hire Americorps members to administer programming at community gardens and schools including agro-ecology (pollinators, water quality, etc.).
HS-2.2.1	Continue to provide enrollment assistance for participation in the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) Program, and other food assistance programs.	Management Practice, Information, Education	Short term	CHIP Basic Needs Action Team	VAC, CMCA, Food Banks, CHA	$	Existing funding	This is already being done through local agencies and is a component of the CHIP Basic Needs Action Team – (one door access for local programs). SNAP and WIC are federally funded with stringent income limits that will not take into account rising costs of utilities, etc. Determine best ways to support the action already being taken by CHIP Basic Needs Action Team.

[3] http://extension.missouri.edu/hes/housing/healthyhomes.htm.

Natural Resources

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
NR-1.1.1	Manage publicly-owned natural areas to enhance and maintain diverse native communities.	Management Practice	Short term	Sustainability	Public Works, Stormwater Utility, Parks & Recreation, W&L	$$$	Reprioritization Grants Partnerships	Conduct a detailed natural resources inventory that assesses land uses and map these areas. Assess current habitat quality of natural areas. Conduct cost-benefit analysis of native habitat management.
NR-1.1.2	Establish and effectively manage native habitat corridors along trails and utility easement areas to restore and maintain landscape connectivity.	Management Practice	Long term	Water and Light	Sustainability, National Wild Turkey Federation, Missouri Department of Conservation, Quail/Pheasants Forever, all utilities, U.S. Fish and Wildlife Service	$$$$	In lieu of mowing/tree removal	Analyze current mowing/maintenance costs, acreage, and staff time required. Map areas that need maintained.
NR-1.1.3	Create an ordinance that establishes a Transfer of Development Rights program to protect undeveloped lands for land conservation and/or agriculture.	Policy	Short term	City of Columbia & Boone County Community Development – Planning	Office of Sustainability, Green-belt Land Trust, Boone County Commission	$$$$	TBD	Conduct an economic study of the county land market in order to Right-size incentives for local land economics and preservation priorities. Perhaps Green-belt Land Trust administers the program and city financially supports. The City and County may work with outside land trusts and agencies to develop an acquisition and Preservation strategy for prime farmland and sensitive land using existing NRI mapping resources and plans. Develop a TDR bank for credits and a conservation and preservation easement program to allow for a robust TDR program.
NR-1.1.4	Support the Urban Forest Master Plan to identify programs and suitable locations to maintain and expand Columbia's urban tree canopy.	Management Practice	Long term	Community Development	Parks and Recreation, Sustainability, Public Works	$$$	TBD	Work with Tree Advisory Board to implement Columbia Forest Master Plan.
NR-1.1.5	Update current tree preservation requirements to protect tree root systems and large legacy trees during construction.	Policy	Short term	Community Development - Planning	Sustainability	$	Existing funding	Explore similar initiatives in peer cities (i.e. City of Springfield, MO tree preservation ordinance protects large trees during construction. Work with City Arborist, building engineers and development community to develop a best practices program.
NR-2.1.1	Complete change to rate structure to encourage reduced water use.	Policy	Ongoing	Water and Light		$$	Water rate increase for irrigation	Monitor and evaluate impacts of rate structure on usage and cost. Continue delivery and development of educational programs for residential, commercial, and industrial customers.

#	Action	Lever	Timeframe	Lead entity	Potential partners	Cost	Funding strategies	Key next steps
NR-3.1.1	Implement strategies to mitigate stormwater impacts due to development and redevelopment of properties currently exempted from stormwater management requirements.	Infrastructure	Short term-research and pilot phase Long term-permanent implementation	Stormwater Utility	Sustainability Community Development	$$$	Stormwater rates, sales tax	• Examine current incentive effectiveness (Sec. 26-169 to 176) and revise as appropriate. • Identify redeveloping neighborhoods for potential projects and develop a plan to prioritize work, • Evaluate successful incentive-based programs for pilot and permanent implementation of small-scale distributed stormwater incentive programs. • Based on pilot results determine appropriate financial incentive (SW credits, fee reduction, etc.) to build a rain garden, bioswale, plant natives, etc. • Investigate potential funding sources for property acquisition and management practices within redeveloping neighborhoods.
NR-3.2.1	Mine existing data sources (e.g., FEMA Risk Maps) to identify areas prone to flooding.	Information, Education	Short term	Stormwater Utility	Community Development	$$	Within current funding structure	Assign staff to compile risk maps and identify at-risk properties and infrastructure. Establish criteria that improve existing regulations Sec 29-2.3(d)(4).
NR-3.2.2	Perform detailed studies to identify areas that are at high risk for flooding and may be prospect for property acquisition or mitigation.	Information, Education	Short term	Stormwater Utility	Community Development	$$	Within current funding structure	Continue to work to revise FEMA maps; budget for flood by-outs, including Matching grant funding. Assign staff to compile risk maps and identify at-risk properties and infrastructure.
NR-3.2.3	Increase stream buffer requirements to provide additional flood water storage and minimize property damage due to erosion and flooding.	Policy	Long term	Stormwater Utility	Community Development	$$	Rate increase	Assess the impact of the benefits of the existing stream buffer ordinance and areas. Include climate projections in flood risk mapping. Where environmental return on investment is high consider revising stormwater regulations, including scenario mapping. Prioritize projects such as property acquisition, infrastructure improvements and mitigation efforts to minimize risks, as funding allows. Ballot Issue.
NR-3.2.4	Perform a flood risk assessment using historical data and future precipitation forecasts to identify areas and critical infrastructure vulnerable to flooding.	Management Practice	Short term	Stormwater Utility	GIS, MU, OEM, FEMA	$$	Reprioritization, Grants	Explore similar modelling efforts in peer cities, evaluate internal capacity to complete or develop RFP for external firm.